SOILS AND MEN

1. How Much Do Farmers Know?

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast Monday, October 3, 1938, in the Department of Agriculture period, National Farm and Home Program, by 97 stations associated with the National Broadcasting Company.

--ooOoo--

KADDERLY:

Beginning today and continuing each Monday for the next several months the Department of Agriculture's part of the National Farm and Home Program will include stories of "Soils and Men" -- stories based on the 1938 Yearbook of Agriculture -- stories told by Gove Hambidge, editor of that Yearbook.

Gove, we are glad to have you with us again.

HAMBIDGE:

Glad to be back, Wallace.

It has often been said and I think rightly, that few occupations demand more different kinds of skill and knowledge than good farming. If the farmer realized what a complex problem he is up against, he might either get a swelled head over the amount he knows, or become completely discouraged thinking about all the things he ought to know and doesn't. Here are some of the things many a good farmer does know and can do:

He knows quite a bit about the soil, at least the soil on his own farm. He knows what crops his soil will grow best, what it needs to make it produce well, and how to handle it under different conditions. In other words, he's something of a practical soil scientist.

Next, he knows a good deal about the crop or crops he grows -- not to mention knowing about the crop he tries not to grow -- weeds. So he is a practical plant scientist.

This knowledge also involves several important side lines. The farmer has to know something about the best varieties of plants to grow. This brings in genetics. He has to know about the diseases that attack the crops. This brings in plant pathology. And he must know about the insects he has to fight. This takes in entomology.

In addition, if the farmer is a livestock man, he knows animals -- the best types of animals for his purpose, how to keep them healthy, and how to make them as productive as possible. This includes a good bit of biology, and especially the branches of biology that are concerned with disease and with nutrition.

Next? Well, farmers are like sailors in that they have to keep a shrewd eye on the weather and watch weather reports and records. They are likely to

(over)

know a fair amount about machinery, at least to the extent of being familiar with the operation, care, and repair of several different kinds of machines. Some farmers are pretty expert at construction work with concrete and stone; at road building; at carpentry and painting; at blacksmithing; and in an emergency, they can do a job of plumbing or electric wiring.

If the average farmer were wrecked on a desert island, he could probably make his way somehow where the average city man would starve to death.

Those things don't tell the whole story, either. Today, the farmer must think more and more in terms of economics. The local market, the national market, the international market- the public utilities and railroads - the stock market - the industrial system, unemployment, depressions -- all of these directly affect his livelihood. He must try to understand them if he is ever to protect himself against the economic shocks that periodically threaten to ruin agriculture.

I don't mean to set the farmer up as a super wise man. Far from it. But I do believe that good farming demands a wider range of skill with the hands and knowledge in the head than most other pursuits. And I venture to say that all of these subjects I've mentioned are things we could afford to study more or less all our lives -- and even then we wouldn't know any too much about them.

That brings me to the fact that the Department of Agriculture is now getting out a series of books each of which covers one of these important fields of knowledge. Many of you know about the two books already published in this series. They are the Agricultural Yearbooks for 1936 and 1937. They dealt with plant and animal breeding. The third book in the series, the 1938 Yearbook of Agriculture, has just recently been published. We hope to build these Yearbooks into a well-rounded set of volumes that will be a worth-while addition to the library of any farmer or agricultural student -- books with permanent value for study and reference.

The 1938 Yearbook is called Soils and Men as Wallace Kadderly said a bit ago. The title explains itself. The book is about soils and their relation to men -- especially the soils of our own country and the people most concerned with them, the farmers of the United States.

The book contains a lot of things I didn't know when I started to edit it. I think you'll find it contains a lot of things you didn't know, too -- things worth knowing and thinking about -- things worth acting on. I am going to cover some of these things in the next several weeks on this program.

The Yearbook on Soils and Men was prepared under the direction of a committee headed by Dr. Henry G. Knight, Chief of the Bureau of Chemistry and Soils. Many different bureaus took part in the work, and over a hundred scientists and economists cooperated in the writing of the articles.

The Foreword, by the Secretary of Agriculture, will give you some idea of the book as a whole. This is what he says. I quote:

"The earth is the mother of us all -- plants, animals, and men. The phosphorus and calcium of the earth build our skeletons and nervous systems.

Everything else our bodies need except air and sun comes from the earth.

"Nature treats the earth kindly. Man treats her harshly. He overplows the cropland, overgrazes the pastureland, and overcuts the timberland. He destroys millions of acres completely. He pours fertility year after year into the cities, which in turn pour what they do not use down the sewers into the rivers and the ocean. The flood problem insofar as it is man-made is chiefly the result of overplowing, overgrazing, and overcutting of timber.

"This terribly destructive process is excusable in a young civilization. It is not excusable in the United States in the year 1938.

"We know what can be done and we are beginning to do it. As individuals we are beginning to do the necessary things. As a nation, we are beginning to do them. The public is waking up, and just in time. In another 30 years it might have been too late."

This is what Secretary Wallace said in the Foreword to the 1938 Yearbook of Agriculture.

I might add that the Yearbook of Agriculture has been distributed free by Congress for a great many years. It's an American institution. Each member of Congress has a certain number of copies at his disposal. If you want one, you can write to your Congressman for it. After the free supply is gone, the book can be obtained only by buying it from the Superintendent of Documents here in Washington.

And that's all for today. Next time I shall go into the subject of soil misuse in this country.

SOILS AND MEN

2. Do We Misuse the Soil?

By Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture period of the National Farm and Home Program, Monday, October 10, 1938, by 95 stations associated with the National Broadcasting Company.

--ooOoo--

Last week I said that today I would take up the subject of soil misuse here in the United States. I give you fair warning that it won't be a rosy picture. On the other hand it must also be said that the problem is far from hopeless. The fact is that we've finally begun to wake up to what we've been doing to the soil and we're trying to find ways to make a better job of it in the future. The country as a whole has made a start in the right direction, and that's a hopeful sign. But it's not going to be easy to undo some of the major evils of the past (and the present, for that matter), or to solve some of our worst soil problems.

When you take a sort of bird's-eye view of the soil problems of the United States, you see that one of the worst comes from farming land that isn't suited for farming at all. That's notably true in some of the hilly areas of the South and the East, and in a good many of the cut-over forest regions -- around the Great Lakes and the Gulf Coast, for instance. C. P. Barnes has an article about these areas in the 1938 Yearbook. Mr. Barnes is connected with the Office of Land Use Coordination in the Department.

Some of the hill farms in the Southeast are a particularly good example. On some of those farms I've seen patches of corn on mountainsides so steep that when I looked up from below the fields <u>seemed</u> to go straight up. They don't really, of course, but they look that way. It must take a human fly, I thought, to plow that land. A friend of mine was inspecting one of those mountain corn fields and I give you my word that he lost his balance and actually fell off of it. Not all the hill farms are as bad as that, but many of them are pretty bad.

What erosion does to the soil on those hills when it's been cultivated very long, or to overgrazed mountain pastures, I leave to the imagination of anyone who's ever seen tons of water tearing down a bare hillside and taking the surface of the land along with it.

Now why do people try to farm those lands? Well, there's just one answer -- they don't have money enough to get any better land; and the longer they stay where they are, the harder it is to better themselves, because the soil gets more and more run down. It's a vicious circle. The more families there are in such a section, the less land there is for any family -- and the harder it is for any of them to make enough of a stake to go elsewhere.

Those are the areas where you will see poverty, undernourishment and general living conditions about as bad as you will find in any city slum. It all goes back to the fact that the soil is simply not suited to the intensive use we try to make of it. (I say <u>we</u>. Those who wash their hands of any

(over)

responsibility for how the other half lives will not agree with the use of that word we.)

The dryland farming areas of the West are just the opposite of the hill areas of the East. The land there is as level as your dining-room table, and the soil is deep and rich. But if the arid West has the soil, the East has the water -- and East is East and West is West, and never the twain shall meet -- or hardly ever. A year of good rain fools people about that deep, rich soil. John B. Bennett, of the Bureau of Agricultural Economics, who writes about this region in one of the articles in the Yearbook, cites the case of a dryland farmer who made over $21,000 in 20 years. This looks like an average of more than a thousand dollars a year. But it isn't. He made about $20,500 of it in one year and the other $600 in all the other 19 years put together.

For many years in succession, in the really dry country, there is too little moisture to grow a crop. Then the wind blows away the parched soil -- soil that has been plowed up and is no longer protected by its natural grass cover. And families by the thousands trek out of that country, bitter and beaten.

Not all the Great Plains and the dry-farming country is like that, of course -- but enough of it is to have caused many human tragedies.

These are not the only examples of striking misuse of the soil. W. R. Chapline, who has charge of range research in the Forest Service, tells in the Yearbook how vast areas of range land in the West have been badly damaged by overstocking and grazing at the wrong season. F. R. Kenney, of the Bureau of Agricultural Economics, points out that some irrigation projects have been flat failures, as often as not because the wrong kind of soil was irrigated. Kenney and W. L. McAtee, of the Bureau of Biological Survey, also write about drained areas in the United States. Drainage is good when it's good, but we've often bitten off more than we could chew and drained land that should have been left under water as a refuge for wild life. Up in Minnesota, for instance, they had a bad experience with the craze for drainage. When the swamps were dried up, the peaty soil promptly proceeded to catch fire. Millions of dollars were wasted, first draining the land and then helping out the people who tried to make a living on it and couldn't.

Many people are likely to say, "Well, after all, those things don't affect me. You're talking about the bad spots, the horrible examples. My land is all right, and I can't see that there's been much if any misuse of the soil around my part of the country."

Well, maybe not. On the other hand, maybe you just don't see the damage-- yet.

In 1937 a rather careful estimate of erosion damage on agricultural land throughout the United States was made by soil experts in the Department and the experiment stations. Some of the conclusions they came to are summed up in the Yearbook by F. J. Utz, who is in charge of erosion control practices in the SCS - the Soil Conservation Service -- and Charles E. Kellogg, who is head of the Soil Survey Division of the Bureau of Plant Industry.

This Nationwide survey indicates that only about 40 percent of all our cropland can be safely cultivated under presentfarming practices. No, that's not quite true. Some land that can be safely cultivated is so poor that there's no use cultivating it unless crop prices are better than they've been on the average during the past 15 years.

What about the other 60 percent of the cropland? Well, that 60 percent has already been damaged by erosion, and it will continue to be damaged more and more unless we take steps to protect it -- that is, unless we adopt better farming practices than we ordinarily use. Of course some of this land also is too poor to be profitably cropped at prevailing market prices.

But I see that my time is up for today. I'll have to quit right in the middle of this report on erosion in the United States. We'll go on with it next week.

KADDERLY:

Free copies of the 1938 Yearbook of Agriculture -- Soils and Men -- can be obtained from your Congressman. After the Congressional supply is exhausted the Yearbook must be ordered from the Superintendent of Documents -- price $1.75.

#####

1.9
In33H

SOILS AND MEN

3. Some Causes of Soil Misuse

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, in the United States Department of Agriculture portion of the National Farm and Home Program, Monday, October 17, 1938.

---ooOoo---

Last week I was talking about a 1937 estimate of erosion in the United States when I had to break off because my time was up. You may remember that the estimate covered erosion damage on agricultural land, and it was made by State and Federal workers. The figures are given in an article in the 1938 Yearbook written by E. J. Utz, of the Soil Conservation Service, and Charles E.Kellogg, of the Soil Survey. In round numbers, the estimate shows that about 60 percent of our cropland has already been damaged by erosion and will be damaged more and more unless we take steps to prevent it by improved farming practices.

This same survey also shows that some 18 percent of all our cropland is definitely submarginal. That land should not be cultivated at all. Much of it, however, is perfectly good land for other uses, such as trees or grass. That's one-fifth of our cropland -- or nearly one acre out of five as an average for the country.

As far as production is concerned, we don't need to use that 18 percent, as a matter of fact. If we ever do need more land under cultivation, we have an ample reserve that could be safely used, although it is not being cultivated today.

Here, then, is the way the situation stands according to this survey:

Nearly a fifth of our present cropland ought to be taken out of cultivation. Against that is an even larger reserve that can be used whenever we really need it.

Four-fifths of our present cropland can be safely cultivated provided we use improved farm practices on a good deal of it. That four-fifths is the kind of land that should yield a satisfactory return at the average crop prices of the past 18 years.

About half of that good land can be used safely even without improved practices.

On the other half, the topsoil will eventually be dumped into the ocean -- some slowly, some very fast -- unless we take steps to handle it better than we've been doing.

Is some of this land that cannot be safely cultivated by present practices on your farm? That's something it would be worth while for you to find out about if you don't already know..

There are other articles in the first part of the Yearbook on soils that I can only touch on briefly.

Here's one, for instance, by E. H. Reed, of the Soil Conservation Service. He writes about how soil losses affect crop yields. Now, that's an important point, and you'd think there ought to be plenty of accurate figures about it. There aren't, though. We know soil losses do affect crop yields, but the question is, how much? One of the things research workers want to do is to get more complete records on that question.

Here's a section on the effects of erosion on floods, streams, reservoirs, et cetera, by J. H. Stallings of the S.C.S. and E. N. Munns of Forest Service. It's rather appalling to learn how fast some of our big, expensive reservoirs get filled up and put completely out of commission by silt washed into them from eroding land. Here are some figures I thought were very striking. Three-year records were made in a certain part of the Appalachian region. They showed that water poured off of a square mile of gullied pasture land during rains at the rate of 785 cubic feet every second. It poured off of abandoned farm land at the rate of 403 cubic feet a second. But it trickled off of forested land at the rate of only 6 cubic feet a second. That tells something about the relation of soil management to the flood problem.

Here's the first article in the book, which is about the relation of soil use to the general welfare. It's by Carl C. Taylor and O. E. Baker, of the Bureau of Agricultural Economics, and Bushrod W. Allin, of the Office of Land-Use Coordination. They tackle some of the most fundamental problems connected with soil use, and present different viewpoints very fairly. They show that at bottom the whole soil problem is a human problem. That can't be put too strongly. In the long run, it is we human beings who suffer for the way we ourselves misuse the soil.

Now we've been dealing with the problems of soil misuse. What are some of the causes of soil misuse in this country? Those causes are human too.

The first of them is ignorance; lack of knowledge. Now ignorance is of two kinds. One kind is shared by everybody, including the most intelligent people living. Nobody, for instance, took precautions against bacteria in the days before Pasteur because nobody knew bacteria caused disease. Nobody used complete fertilizers in the days before chemistry taught us the need for them. That's universal ignorance. The other kind of ignorance is not general but individual. Certain facts about good soil management are widely known today, but some farmers are ignorant of them. Both these kinds of ignorance have caused, and still cause, much misuse of the soil.

On the other hand there are some things that I know I ought to do on my own small place right now -- but I can't afford to have them done and I haven't the time to do them myself. This brings up the second great cause of soil misuse, which I might call human institutions of various kinds. Poverty is only one of them.

You might include among these institutions certain points of view and certain ways of doing things that we Americans have built up as a people. L. C. Gray, of the Bureau of Agricultural Economics, discusses some of these traditions in the Yearbook. For instance, in the beginning we had an enormous continent to clear and settle just as quickly as possible. We did that job with ax and plow in a remarkably short time. But in the process we were somewhat careless -- to put it mildly.

We believed everyone ought to have a piece of land he could call his own, so we made it easy for homesteaders to acquire a stake. But we also made it easy for rich individuals and corporations to get huge gobs of land for little or nothing. Some of these individuals and corporations cleaned out vast forests with no regard for the future. Some of them also made huge profits by land speculation. And many farmers were left holding the bag. At the peak of a boom they paid more for land than it would ever produce. At the bottom, they couldn't meet mortgages and lost all they had.

The very first time the Census Bureau started counting tenant farmers was back in 1880. Even at that date, it was found that a fourth of all our farmers were tenants. Our American ideal of ownership didn't work out very well for that fourth of our farmers.

Our land policy, in other words, was a hit-or-miss one that accomplished many splendid things but also encouraged a certain recklessness toward the land. And with that I shall have to leave you. We will go on with this discussion next week.

SOILS AND MEN

4. More Causes of Soil Misuse

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture in the U. S. D. A. portion of the National Farm and Home Program, Monday, Oct. 24, 1938.

---oo0oo---

Kadderly:

All set, Bill Crago - -

And first, we'll call on Gove Hambidge, editor of the 1938 Year Book of Agriculture.

Gove is meeting with us each Monday - - and each time he comes he takes up more of the many things found in the Year Book. "Soils & Men" - - that's the title of the 1938 year book - - - and those three words - - well they are exceedingly illuminating - - you can't separate them, can you Gove?

Hambidge:

In our discussion last week we began to take up some of the causes of soil misuse here in the United States. For one thing, we saw that ignorance is one of the big causes. If I have a piece of land, I may manage it as well as I know how-- but there may be a lot of things I don't know. For another thing, we saw that the conditions of American history made for a certain carelessness in the use of the land. We had so much land to clear that we had to do it in a big way. No one could accuse us of being penny wise and pound foolish; we were just the opposite. We gave away land to anybody who wanted it. We believed every individual had a right to land, and there were no restrictions on what he did with it.

Europe went through somewhat the same development in the great upsurge of individual freedom that came along about the time of the American Revolution and after. But Europe soon had to make some reforms, as Erich Kraemer of the Farm Security Administration and W. N. Sparhawk of the Forest Service point out in one of the Yearbook articles. There was much less land in Europe, and people felt the pinch much more quickly than we did. It was necessary to try to work out laws that would protect the farmer from losing his holding, but also make him more responsible for good soil management and soil conservation in the interest of the country as a whole.

I have mentioned that as early as 1880, a fourth of our farmers were already tenants. In another Yearbook article three men in the Bureau of Agricultural Economics -- J. G. Madox, R. Schickele, and H. A. Turner -- deal with that subject of farm tenancy. Their general conclusion is that tenancy in itself is not responsible for misuse of the soil, but the conditions under which tenants commonly have to operate are responsible.

For instance, if a farm is rented on a crop-share basis, the owner wants to get all the cash he can out of the place. Therefore it's to his interest, and that of the tenant also, to use as much land for cash crops as possible. Now generally speaking, cash crops are the crops that do most to expose the soil to erosion and loss of fertility. Farmers know that the more land they have in grass and legumes, either in rotation or permanently, the

better it is for the soil. But grass and legumes are not cash crops, and crop-share renting discourages their use.

Again, suppose a tenant does improve the farm by actually building up the soil. That costs money. Does the owner compensate him, say by reduced rent or something? In the past it generally worked out just the other way. It paid the tenant to do as little as possible in the way of improvements.

It has been said of tenants that they're here today, gone tomorrow. But is that due to something peculiar in the nature of tenants? Or are they ordinary men and women who would like to stay put but who move around because the tenant system generally causes them to act that way? If the latter is the case -- and I think you'll agree it is -- then the thing to do is to try to correct the system so the tenants can stay put.

This is one of our most important problems. In 1935 not far from half the farmland in the United States was operated under lease -- 45 percent to be exact.

A lot of tenants, incidentally, are operating farms that are too small to furnish a decent livelihood. The same thing is true of some farm owners. When a man has a patch of land not much bigger than a large-size pocket handkerchief, he pushes it to the limit to make it produce as much as possible. There you have another cause of misuse of the soil. The relation of the size of the farm and other factors to good or bad use of the soil is discussed by M. R. Cooper of the Bureau of Agricultural Economics and W. J. Roth of the Soil Conservation Service in the Yearbook.

You might sum up a good many of these points I've mentioned like this: Whatever causes heavy financial pressure on the farmer also causes misuse of the soil, because the farmer can meet his obligations only from the products of the soil. He has to make ends meet if he can, and under pressure he may do things that he knows are not good for the soil.

Two things that often cause heavy financial pressure are mortgages and taxes.

The ordinary mortgage, as David L. Wickens of the Farm Security Administration points out in the Yearbook, is seldom drawn up with any idea of protecting the soil, even though the soil is actually the principal asset back of the mortgage. The mortgage may provide that you have to keep the house and buildings in good repair, but it seldom says a word about keeping the soil in good repair. Moreover, farm mortgages in general have not been very well suited to the nature of farming as a business. They're drawn up on the basis of a steady income and don't take account of droughts, farm depressions, and other knockout blows.

Somewhat the same thing can be said of property taxes, especially for certain kinds of production, like forestry. Forest land -- and that includes farm forest land -- produces little or nothing during a long period of early growth, yet taxes go on just the same. The result is that the land is not used for trees but for something that will produce an income to meet the tax bill. This is aside from the question of whether property taxes are too high

anyway, whether they bear down too hard on farming as a business. The whole question of taxes as one cause of soil misuse is discussed in the Yearbook by R. Clifford Hall of the Forest Service and Donald Jackson of the Bureau of Agricultural Economics.

We seem to have got pretty far afield into things that have no relation to the soil. But they do. In fact we can go still farther afield and still be talking about the soil. Certain broad economic questions that affect the whole country, industry as well as agriculture, have a large bearing on soil use. Some of these broad questions are considered in a Yearbook article by Louis H. Bean and J. P. Cavin of the A. A. A., and Gardiner C. Means of the National Resources Committee.

The war caused us to plow up many acres that would not have been plowed up otherwise. The big boom of the 1920's kept production going full blast. The great economic depression that began in '29 nearly ruined agriculture. Farm prices and income became subject to more and more violent ups and downs -- expecially downs. Industry threw millions of people out of employment -- but agriculture had to feed them just the same. All of these things are hard on the soil. It can't be otherwise. The soil problem is a human problem.

And that's as far as I can go today. Next week we'll take up the possibility of finding remedies for some of these causes of soil misuse.

<u>Kadderly:</u>

And that's a logical sequence, Gove --for causes of soil misuse -- to some remedies.

Gove Hambidge will be with us again a week from today. He is editor of the 1938 Year Book of Agriculture of the U. S. D. A.

Would you like to have a copy of this Year Book? You can get a copy free, by addressing a request to your U. S. Senator -- or to the member of the House of Representatives from your Congressional district. The 1938 Year Book of Agriculture -- free -- so long as the Congressional supply lasts.

SOILS AND MEN

5. Here Are Some Remedies.

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, in the Department of Agriculture period National Farm and Home Program, Monday, October 31, 1938.

---oooOooo---

When a scientist finds the cause of a disease, he's taken the first big step toward discovering a cure. Before that, he's working pretty much in the dark. The same thing applies to the soil.

In the discussion last week we tried to pin down several definite causes of soil misuse in the United States.

Ignorance we found to be one of them. People don't always know what _is_ good soil practice. Another was the abundance of good land in this country, which made us careless about how we handled it and gave it away. The Wall Street state of mind was another. Instead of thinking of the soil as a steady means of livelihood, many people played for a rise in the land market, hoping to sell out and get rich quick. Again, not tenants themselves but the tenancy system has often worked to the disadvantage of the soil -- over a large area, too, since nearly half our farmland is now operated under lease.

Finally, just as financial pressure and worry have caused many a man to work himself into a nervous breakdown, so they have caused many a farmer to work the soil into a nervous breakdown. This financial pressure may come from several causes at once, including heavy mortgages, burdensome taxes, so-called overproduction and low prices, loss of markets through unemployment at home or a slump in trade abroad, and in general the whole business of violent ups and downs that characterize what we call the economic cycle.

Obviously some of these causes of soil misuse are pretty tough to eliminate. Others might go down with one big push. You never know till you try. Joe Lewis did it with Max Schmeling, and Douglas Corrigan did it with the Atlantic Ocean.

Today we're going to consider some of the remedies suggested by these causes.

Ignorance, as I have suggested before, is of two kinds. General ignorance is what nobody knows, not even the best scientists. Now there is unquestionably a great deal that we don't know about the soil. In fact, soil science is a very young science. The only remedy for this kind of ignorance is continued research, and plenty of it. Charles E. Kellogg, head of our Soil Survey Division, tells about some of our research needs in one of the articles in the Yearbook. It's quite conceivable that some day people will look back on our present knowledge of the soil just about as we would look back on the state of knowledge of the caveman. When that day comes, people will handle the soil much better.

(over)

Personal ignorance is another matter. The only remedy for that is education. Schools, churches, radio, movies, newspapers can all help to give us sound knowledge of how to deal with soil problems, especially in localities where soil misuse is tied up with the worst human misery. Education, like research, is a long-time job, one that never ends. It is especially important in a democracy like ours because we expect people to decide things for themselves, and decide them intelligently.

Many agencies are carrying on educational work about the soil today-- in fact, there's more of it than ever before. I'll mention only two of them.

One is the Agricultural Extension Service, which has been plugging away steadily at the educational job for many a long year. C. W. Warburton, head of the Extension Service, tells in the Yearbook about the many different methods the Extension people use, and what they accomplish in the way of getting farmers to adopt good soil-conserving practices voluntarily.

The Soil Conservation Service has also carried on a big educational job in the past few years, in its demonstration areas throughout the country. Maybe you're familiar with that work. If not, I advise you to visit the nearest demonstration area; my hunch is that you'll find it an eye-opener. C. B. Manifold, of the Soil Conservation Service, describes this work in the Yearbook.

Last summer I went over one of these areas in a hilly region in the South. I found that on every cooperating farm the whole look of the land had been changed. Every modern method for saving and building up the soil, and at the same time improving production, was being used on these farms. It was neat, believe me it was neat. In this job, the farmers and the S.C.S. crowd--they were practically all local men, by the way, not outsiders -- work out the plans together.

This is an educational job because when other farmers see how these methods actually work out on farms in their own neighborhood, they go and do likewise. At least that's what's supposed to happen. On the other hand, people are queer, as someone has said before. I remember how, when I was a boy, we used to laugh at the first automobiles. They were amusing to watch, but shucks, they wouldn't ever amount to anything. That's what we thought. I miss my guess if a lot of farmers don't feel that way about these new soil-conservation demonstrations.

Along with research and education as remedies for soil misuse I might put land-use planning. C. P. Barnes, of the Office of Land-Use Coordination, writes about this in the Yearbook.

Land-use planning is something of a new term in this country. What does it mean and how far does it go? It means deciding what is the best use for a given kind of soil in a given area, and then making practical plans to put it to that use. If it had been possible to follow such a method in the past, some of the worst soil misuse in this country would never have occurred.

But you have to watch your step in land-use planning. It's a safe thing not to try to make a plan for land use beyond what our present knowledge justifies. Another safe thing is to collect all the facts from every possible source

before saying this should be done or that should be done in a given area. Still another is to make sure that everybody concerned is called on to cooperate, and especially to rely a good deal on local experience.

Land-use planning does not mean going into detail regarding the use of every piece of soil. But it is possible to say, for instance, that such-and-such areas are so poorly suited to cultivation that anyone who tries to farm them will almost certainly make a miserable failure of it. Such areas can be gradually removed from agricultural use and kept for forests, for grazing, for recreation, for wildlife. The question is whether we'll do that or let thousands of people make the same tragic mistakes over and over again, and have to go on relief in the end.

As far as I can see, land-use planning of this kind is simply common sense. If the United States were so poor that we had to use every inch of land to raise food, it would be a different story, of course. But we're not. Then why should we continue trying to farm land that is not suited to farming? It's like trying to squeeze blood out of a stone.

Right at this point I'm afraid I'll have to call it a day. Next time I'll pick up this subject where I'm leaving off now.

SOILS AND MEN

6. More about Remedies for Soil Misuse

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, in the Department of Agriculture period, National Farm and Home Program, Monday, December 12, 1938.

--ooOOoo--

The last time we met on the air, I was discussing some of the possible remedies for soil misuse here in the United States. Among them were scientific research, to discover better soil management practices; education so more people can apply what we already know; and land-use planning, in its broad sense. That includes retiring submarginal land that is not suited to farming. Farming such land is bound to lead to hardship and misery in the long run.

Now any policy of retiring submarginal land involves a certain amount of buying up of land by the Government. You will find that subject covered by C. F. Clayton, of the Bureau of Agricultural Economics, in one of the articles in the soils Yearbook. Clayton makes the point that public purchase of land should be used only as a last resort, when there's no other good way out. But even if public purchase is confined only to the most necessary cases, there's a good deal of land that probably should be bought up and retired.

But a great deal of land is already publicly owned. What about the management of that? Has it all been perfectly run, by the best modern standards? Apparently it has not. Several writers discuss this question in the Yearbook -- Earle H. Clapp, E. N. Munns, and I. H. Sims of the Forest Service, and George S. Wehrwein of the University of Wisconsin.

They point out that improvements can be made in the management of the vast area of range land in the public domain in the West, and that more research is needed to determine the details of the best soil management in our great National Forests. In the case of State-owned land Professor Wehrwein argues for a clean-cut policy of putting these areas to their best use, which in most cases would be for forests, grazing, hunting, fishing, camping, and so on. Some States are proving that there are good possibilities for income from public land when it is properly managed.

When it comes to privately owned land -- your land and my land, for instance -- the problem of insuring good soil-conserving practices is infinitely more complex. Education will solve part of it. If I know how to manage my soil well and I'm convinced that it pays in the long run, as well as being to the advantage of the country as a whole, I'll do it. But education won't solve everything. The problem is not as simple as that. I wish it were. What is really needed is to examine each of the many causes of soil misuse I've discussed in previous talks and patiently try to find a good remedy for each of them.

(over)

For instance, one cause of soil misuse we discussed is tenancy -- not tenancy in itself but the way tenancy works. Well, then, why not make it work better? Instead of penalizing a tenant for improving the soil, why not make it worth his while to do exactly that? For instance, why not put it in a contract that when he leaves the farm he gets paid for whatever added fertility is left over from the fertilizers he used, or the legumes he planted, or what not? Something like that is being done in England today. Again -- instead of making it possible to throw a tenant out on his ear the minute his year's lease is up, why not have a lease that would run, say, for five years, renewable at the end of every year? These are just two possibilities. Many others are discussed by Marshall Harris of the Bureau of Agricultural Economics in one of the Yearbook articles.

Our farm tenancy system just grew. In many ways it no longer suits modern conditions. By changing it enough to suit modern conditions, we could go a long way toward improving the soil on an enormous amount of good American earth.

Another cause of soil misuse is the pressure of heavy mortgages. There again it should be possible to make changes for the better. Farm income is up one year, down another. Mortgages don't allow for that; the farm owner has to make the same payments no matter what his income. Well, why not have flexible payments according to the amount of income? (Of course, I'm speaking of amortizing mortgages, payable in instalments.) Such an arrangement would be a godsend for many farmers during hard periods. Some mortgages being made under the Bankhead Jones Act do have this arrangement. In return for making things easier for the farmer, there might be some definite provision in the contract for him to maintain the soil in good condition. Other possibilities for improving the mortgage situation are discussed by David L. Wickens, of the Farm Security Administration, in a Yearbook article.

Property taxes may also contribute to soil misuse. Now this tax business is a complex problem. But there's little doubt that taxes could be reduced, in many cases, if we were willing to take such steps as reorganizing local governments for more efficient operation at less expense to taxpayers; using better appraisal and collection methods; doing away with the overlapping of some of our tax districts; and not relying so heavily on property taxes to carry the cost of government. In other words, the tax system is in need of some streamlining to bring it up to date, as Donald Jackson of the Bureau of Agricultural Economics and R. Clifford Hall of the Forest Service point out in the Yearbook.

Another factor in soil misuse is that many farmers who would like to adopt more or better soil-conserving practices can't afford to do it. Can anything be done to help them? Well, in the last few years this problem has been tackled in two ways. First, under the A. A. A., payments have been made to farmers who put a certain amount of their land into soil conserving crops. These are called conditional grants because they're made on condition that certain things are done. Second, the Soil Conservation Service and other agencies have given technical services free to

farmers who wanted to adopt approved soil-conservation practices. In some cases machinery has been provided, and C. C. C. labor, and T. V. A. fertilizers. These are direct aids for soil conservation, and they are discussed in the Yearbook by O. V. Wells and J. P. Cavin of the A. A. A., and D. S. Myer of the Soil Conservation Service.

There are other remedies that can be applied to give us better soil use, too. Some of them are being applied. But those I'll have to take up the next time we meet. I see my time is up for today.

###

SOILS AND MEN

7. Soil Misuse - Some Additional Remedies.

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, in the Department of Agriculture portion of the National Farm and Home Hour Program, Tuesday, December 27, 1938.

---oooOooo---

Last week, no, it wasn't last week--two weeks ago--I was discussing some of the remedies that might be used to solve the complex problem of good soil use in this country. Let's see--how far did we get? We considered the question of Government purchase of the worst submarginal land, so it could be retired from cultivation; and better management of our immense areas of publicly owned land; and improvements in the tenancy system to make it financially worth while for tenants to build up the soil on rented farms and better mortgage contracts - mortgages better suited to the business of farming; and possibly reductions in property taxes. All these would give a better chance for improved soil practices.

Several other commonsense methods for dealing with soil-conservation problems on privately owned land are outlined in the Yearbook. For instance, there's rural zoning. Rural zoning simply means that certain areas might be zoned or designated by the State for farm and non-farm uses. Something like that is being tried in Wisconsin and Michigan, and George S. Wehrwein of the University of Wisconsin and Clarnece I. Hendrickson of the A. A. A. discuss the method in the Yearbook.

Again, in several northwestern States where overgrazing is the most serious problem, ranchers have recently been organizing cooperative grazing associations. These associations draw up rules for the best use of range land, and the members agree to abide by the rules. This is a development and it's described in the Yearbook by M. H. Saunderson of the Montana experiment station.

While we're speaking of the West, I might mention irrigated land. Irrigation has made it possible to grow fine crops on a lot of soil that would otherwise be useless. But more than one irrigation project has gone on the rocks, or the settlers have had a though time to make a go of it. When you look into these failures, you find that they're due to such things as wrong selection of land in the first place - or something haywire in the financing or accounting methods - or a number of very practical other causes. There is less and less excuse for such mistakes today. Some suggestions for preventing these mistakes are given in the Yearbook by Francis R. Kenney of the Bureau of Agricultural Economics.

Then there's the problem of people who are practically stranded on land that is nearly worthless for farming. How can we remedy that? Well, when a man is marooned on a desert island, you can either leave him there and keep bringing supplies to him indefinitely, or you can rescue him and bring him back to civilization. Usually he'd rather be rescued - and it's also less expensive. In the case of stranded farm families, rescue means moving them somewhere where they can make a living.

(over)

That's what's called resettlement.

Resettlement is not a new idea, by any means. It's an old American tradition for the Government to help people relocate elsewhere; that's exactly what homesteading was. But the problem is not so simple today as it was in the homestead days, because there's no longer a frontier with millions of acres of good free land. But it's up to us somehow to make frontiers of opportunity for stranded farmers. As Carl C. Taylor of the Bureau of Agricultural Economics points out in the Yearbook, resettlement is the only apparent solution in some cases, even though it does bristle with difficulties today.

The most important and widespread of all the remedies for the soil being tried right now is the organization of soil-conservation districts. These districts are organized under State laws modeled after a standard act that was drawn up by the Federal Government in 1937.

The general set-up of the soil-conservation districts is described in the Yearbook by Philip M. Glick of the Solicitor's Office. What it amounts to is this: Instead of one farmer carrying out soil-conservation practices over here and another over there, and neither one doing much good because floods get started up younder where some other farmer refuses to do anything to protect the soil - instead of that scattered individual action, the whole community gets together, organizes, draws up soil regulations, and applies them throughout the entire district. A soil-conservation district can be started if 25 farmers ask for it and the majority vote of all the farmers is in favor. Land-use regulations for the district also have to be passed by a majority vote. But once the farmers decide they want these regulations, then the regulations can be legally enforced, like traffic laws or health regulations. On the other hand, any regulations that don't work out well can be changed or even repealed by a referendum vote.

This is the barest outline of the soil-conservation districts plan. It's probably the most broad-scale attack on the soil-conservation problem yet made in this country. If it works, it will prove once more that we can get big things done by cooperative action in a democracy.

None of the remedies I have mentioned so far, however, attacks a practically universal cause of soil misuse. That cause is financial pressure on farmers caused by low prices, surpluses, disorganized markets, depressions, and wars. These are the biggest of all our problems and I'm not going to try to handle them here. I'll leave that to the economic experts. But whether a problem is big or little, the general method of approach is the same. First find the cause - then attack that cause as vigorously as you can.

Two broad attacks have been made on these economic problems in the last few years. First, agriculture has tried to deal with its <u>own</u> difficulties by such methods as you are familiar with in the agricultural adjustment acts. Those methods are dealth with in the Yearbook by O. V. Wells of the A. A. A. Second, the Nation as a whole - and that includes

industry as well as farmers - has been making heroic efforts to remedy some of the biggest dangers in our economy. These efforts are discussed in the Yearbook by Bushrod W. Allin of the Office of Land-Use Coordination.

All such efforts to make our economic system work better have a direct or indirect bearing on the soil. The farmer who is making desperate efforts to keep his head above water can hardly help neglecting many things he knows ought to be done on his farm. We must try to make our whole economy more stable for everyone if we are going to make the best use of the soil.

Now whatever we do to improve soil use must be done under the laws of the land - which means under the Constitution of the United States as it is interpreted by the Supreme Court. This whole question of the legal aspects of soil conservation - how remedies get put into law - is an interesting and a vital one. You will find that question discussed by Philip M. Glick, of the Solicitor's Office, in one of the Yearbook articles.

And that's all I can say today. Next time we meet I promise to get away from these broad economic and social problems and begin tackling practical questions of soil management on the farm.

#-#

SOILS AND MEN

8. What All Good Soils Need

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture portion of the National Farm and Home Hour Program, Thursday, Dec. 29, 1938.

--ooOoo--

So far in this series we have dealt with certain economic and social aspects of the soil problem in the United States. What we found is this: There isn't just one cause of erosion and loss of soil fertility. There are many causes. Each cause has to have its own remedy.

Those economic and social remedies are considered in Part 1 of the Yearbook, Soils and Men. But the Yearbook has five parts. Today we come to Part 2. Part 2 takes up farm practices and methods of managing the soil.

Now good soil management is not a terribly difficult thing. Broadly, it depends on comparatively few principles. I'd say five points are of first importance. First--use good tillage practices. Second--keep up the supply of organic matter in the soil. Third--correct soil acidity - that is, in the humid regions. Fourth--provide an adequate supply of phosphorus. And fifth--do whatever else is necessary to control erosion. There are other points, yes -- but in general, those are the Big Five: Tillage; organic matter; soil acidity; phosphorus; erosion control.

I'm going to pass over the question of tillage very briefly. Tillage is about the first thing the farmer thinks of , because one of the first things he does is to break the soil with the plow. But there are many bulletins and other publications on good tillage practices. John C. Cole and O. R. Matthews of the Bureau of Plant Industry have an article on tillage in the Yearbook, and R. B. Gray, of the Bureau of Agricultural Engineering, has one on tillage machinery.

The main purposes of tillage are to prepare a seedbed, to keep down weeds, and to improve the physical condition of the soil. Good tillage also helps to conserve nitrogen, save moisture, - prevent erosion and even keep down some plant diseases and insects. (And poor tillage may do just the opposite.) The farmer has to answer two practical questions: When shall I plow and cultivate? And how much and what kind of cultivation shall I give? There's no general rule that applies everywhere; when and how much the farmer cultivates depends on the kind of soil he has, the kind of crops he's growing, the lay of his land, and the climate. What's good practice in one part of the country may be all wrong in another.

There is one general rule though. Tillage is expensive in time, labor, and money. The rule, then, is -- cultivate the soil enough, but not a bit more, than is necessary to get the desired results.

Good tillage, economical tillage, is partly a matter of using the right tools. Nowadays there's a remarkable variety of plows, harrows, cultivators, and weeders for different kinds of jobs under different conditions. Some of these implements are fairly new -- the basin lister, for instance,

and the sugarbeet cross blocker are new, special tools. R. B. Gray tells in his article how these various tools work and what they do. He also tells about some recent experiments that have been made to compare the effect of different methods of cultivation on costs, crop yields, saving of moisture, condition of the soil, and so on. You can save money by using the right methods.

Now, leaving the subject of tillage -- what, in general, are the deficiencies in the soil that farmers have to guard against and correct? A moment ago I said that two deficiencies of major importance are, a deficiency of organic matter, or humus, and a deficiency of phosphorus. Over large areas in this country, the soil no longer has enough organic matter or phosphorus. The result is loss of fertility, increased erosion, and low crop production. I believe it can be safely said that these are the two most important soil deficiencies in many farming sections.

William A Albrecht, who is Professor of Soils in the University of Missouri, writes on the broad question of organic matter in the Yearbook.

He points out that virgin soil, never cultivated by man, has a well deserved reputation for being extremely fertile. Yet no fertilizers have ever been added to it. But if nothing has been added, neither has anything been taken away. Virgin soil is just as nature made it. Native plants grow up, they die, they fall to the earth, they decay there, and they become part of the soil. All the chemical substances those plants used when they were alive still are in them when they are dead. All those chemical substances return to the soil. The dead plants nourish billions on billions of soil bacteria, which use part of those chemical substances and release other parts so that new plants can use the chemicals over again. So the soil is kept in a constant state of natural balance a living balance that depends on this return of organic matter.

But the chemical elements in the plants don't tell the whole story. After all, a farmer can add chemicals to the soil in fertilizers. He cannot do certain other things that organic matter does. These decayed plant remains keep the soil light, porous, divided into small separate granules, and full of billions of little air spaces and holes. This porousness of the soil enables water to soak into it - it enables roots to grow easily - and it favors the kind of chemical action needed to feed plants.

Nature had kept a balanced soil for millions of years. Then man comes along and suddenly changes this natural balance. The farmer can't leave his crops to decay on the ground naturally; he doesn't produce crops just for the fun of it. Yet by removing his crops year after year, he enormously reduces the amount of organic matter that would have been returned to the soil under natural conditions. By continually removing crops, we reduce the supply of important chemical substances in the soil, and we also change the structure of the soil. The soil loses those fine separate granules, those billions of little air spaces and holes, and that light porous feeling. It becomes harder and more compact, as though it had been pressed down. Then the first thing you know, water no longer soaks in like it used to; it begins to run off; and when water runs off the soil, you have an erosion problem.

Just that kind of thing has happened over a great deal of the United States. But it is not necessary to continue letting it happen. We can return organic matter to the soil, we can keep up, not exactly nature's balance, but one very much like it. But in order to prevent loss of organic matter, we first have to realize the importance of organic matter and think in terms of organic matter. That is what we haven't done, or haven't done enough.

Well, this is as far as I can get today. Next time I'll go on with some of those other soil deficiencies besides organic matter.

##########

SOILS AND MEN

9. When the Earth is Hungry

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture portion of the National Farm and Home Program, Wednesday, January 11, 1939.

--ooOoo--

The last time I was on this program I began talking about the practical problems of soil management. Five principal points were mentioned -- five things that must be kept in mind in many of our farming regions. First, tillage practices that fit the region, the soil, and the type of farming. Second, keeping up the supply of organic matter in the soil. Third, insuring a liberal supply of phosphorus - and phosphorus in forms that plants can use. Fourth, counteracting soil acidity (that applies to the humid regions). Fifth, doing whatever is necessary to control erosion.

We got as far as the point about phosphorus last time.

Now on this question of phosphorus. There are soil scientists who say low crop production and poor stands in pastures are more often due to a lack of phosphorus than any other chemical element. Crops that are harvested and sold and those that are fed to livestock remove some 2 million tons of phosphorus from the soil in the United States every year. Another 2 million tons is washed away by erosion. And a good deal of the phosphorus that's left is in the form of chemical compounds in the soil that plants can't very well use. In acid soils for instance much of the phosphorus is combined with iron and aluminum, and in this combination the phosphorus is almost useless to plants.

A shortage of phosphorus is not difficult to correct if we give it proper attention. We have large phosphate deposits in this country, fortunately, to use for fertilizers; and on acid soils lime can be used. Lime will make later additions of phosphorus more readily available to plants on acid soils.

W. H. Pierre, who is now head of the department of soils and crops at Iowa State College, writes on phosphorus in the Yearbook. He calls phosphorus the master key to successful agriculture. The Master Key -- that's pretty strong. But I think a good many soil scientists would agree with him.

Every farmer knows that there are two other fertilizer elements besides phosphorus that are of great importance. Those two are nitrogen and potassium. N, P, K -- nitrogen, phosphorus, and potassium -- those are the three elements needed in the greatest quantity by plants. In the Yearbook, Oswald Schreiner and B. E. Brown of our Bureau of Plant Industry write about nitrogen, and the same authors have collaborated with H. P. Cooper, Director of the South Carolina Agricultural Experiment Station, in an article on potassium.

The natural supply of nitrogen in the soil is tied up rather closely with organic matter. This is because nitrogen is one of the principal elements in living tissue, where it exists in very complex compounds. When plants die, these once living tissues are attacked by soil bacteria. The

(over)

bacteria break down the complex compounds and release the nitrogen in simpler forms so it can be used again by the roots of new plants. So if the supply of organic matter in the soil is reduced, the main natural source of nitrogen is cut off just that much. That's one reason why organic matter is important. Legumes especially add nitrogen to the soil because there are certain bacteria on their roots that can fix nitrogen from the air.

As for potassium -- that element is probably present in all soils, to some extent anyway. But potassium too can be reduced below the limit of safety. Some of you will remember that at the time of the war, when we were dependent on German potash and the supply was cut off, cotton and tobacco and some of the root crops got diseases that were due to a lack of potash. Potash hunger, it was called. In general a deficiency of potash quickly shows up in reduced crop yields and poor quality.

I'll be coming back to this question of fertilizers again in connection with some other Yearbook articles. But right now I'm going to go back to the subject of organic matter, because at this point there are a number of articles in the Yearbook that deal with various aspects of organic matter.

Now nature's method of keeping the soil rich is very simple and just about perfect. Under natural conditions -- everything that grows eventually falls back on the earth and decays there. Farmers, of course, can't give their crops back to the earth. They grow plants to use, not to let them rot. Even so, there's an enormous amount of waste matter that might be returned to the soil. What do we do with it? We send it down the sewers -- burn it up in incinerators -- dump it out in the ocean as garbage. (I'm speaking of the cities, of course; that's where most of our farm products go -- to the cities.) From nature's standpoint this is terribly wasteful. Nature would use every bit of this stuff. She would use it to make good rich soil.

There's a hint of what we ought to do ourselves -- use the waste.

But even if we did use all the waste organic matter, it wouldn't be enough. We need to actually create or grow a certain amount of organic matter just for the purpose, or partly for the purpose of turning it back to the soil. The way to do that with the least trouble and expense is to use rotations, particularly rotations that include a liberal planting of legumes. Then these cover and green-manure crops, such as grass, rye, and clover can be plowed back into the soil.

This use of rotations is very much like the old practice of returning a tithe to the Lord. Maybe you think that's a sentimental notion. Well sentimental or not, it's as old as civilization, and even older. There was a time when no one would think of eating a meal without setting aside some food for the gods. The Christians always gave a part of the returns of their labor -- the tithe or tenth -- to the church. Giving a part of what we grow back to the earth is like that. We can think of the earth as being always hungry. It must be fed. If it is not fed, it can't work for us. Is that a sentimental idea or is it plain commonsense?

But a tithe or tenth is not enough in this case. A fourth or even a third of the land, in rotation, may profitably be devoted to food for the earth. I say profitably. The earth has a big appetite, and it works well only when it is well fed.

I'm going to have a little more to say about this subject of rotations when we get together next time. Meantime I guess this is as far as we can get today.

# # # # #

SOILS AND MEN

10. Ways of Supplying Organic Matter

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, in the Department of Agriculture period, National Farm and Home Program, Tuesday, January 17, 1938.

--ooOoo--

Last week, after going briefly into the subject of phosphorus, nitrogen, and potassium, we began to take up the very important question of organic matter. Now organic matter might be thought of as the natural food of the soil, from which it builds its body, just as we build our bodies from food. In a great many soils, the greatest single need is to return more organic matter than we commonly do return in farming operations. Probably the most practical way to do this, everything considered, is by the use of crop rotations.

There's an article on crop rotation in the yearbook by Clyde E. Leighty, of our Bureau of Plant Industry, and it's followed by one on cover and green-manure crops, written by A. J. Pieters and Roland McKee, of the same Bureau.

Now what do rotations do when they are properly planned? First of all, they provide for a systematic return of organic matter to the soil. But rotations are valuable for other things, too. They insure the growing of different crops, so that not all the farmer's eggs are in one basket as it were. Some of these crops furnish roughage and pasture for livestock, and the livestock return additional fertilizer elements to the soil. Rotations often enable the farmer to use commercial fertilizers to the best advantage. Again, a good rotation shifts the location of plant roots. You can grow shallow-rooted crops on a field one year and deep-rooted crops another year, and that helps to distribute the plant food supply through the soil and to keep the plant foods from being exhausted in any one place. Rotations are also very valuable in controlling weeds, and they may help to keep down some plant diseases and insects. Finally -- and this is very important -- rotations help to prevent erosion if they are planned so that there are always thick-growing crops on part of the land.

The question of what particular rotation should be used on a farm is discussed in the two articles I've mentioned in the Yearbook. Every region and every type of farming has its own special rotation system. The system used on a cotton farm in South Carolina will naturally be different from the system used on a dairy farm in Wisconsin, or a corn-and-hog farm in Iowa, or say, a general farm in the Willamette Valley of Oregon. On the other hand just because a certain rotation is widely practiced in your part of the country, that doesn't say it's the best that could be used. There may be room for improvement.

This whole question of a suitable rotation is one the farmer wants to consider very carefully. He has to take his soil into account, and the slope or lay of his land, and the distribution of his labor over the year, and, most important, what it pays him to grow. He will want to work out a plan good enough and sound enough to followed for many years. At the same time, sticking to a plan just because you've always followed it can be a

(over)

mistake too. There might be a better system adaptable to your farm.

I'd like to emphasize two fundamental points here. One is that row crops are generally the hardest on the soil. Row crops are likely to be heavy feeders, and they keep the soil bare between the rows. On sloping lands bare soil gives a chance for erosion. If we could consider only the needs of the soil, row crops might be grown very little. But farmers do have to make a living. So we compromise. The compromise consists in keeping row crops off enough of the land each year to play safe, That's fundamental.

The second fundamental point is the difference between legumes, like clover, and non-legumes - like rye. Some non-legumes used as cover crops actually return more organic matter to the soil than a legume. But consider what happens when cover crops are turned under. The plants are attacked by soil bacteria, which break down the plant tissues. In order to do this work, the bacteria have to have nitrogen. Now non-legumes contain very little nitrogen, comparatively speaking. So the bacteria may have to get the nitrogen they need largely from the soil itself. So when non-legumes decay in the soil, the decaying process may actually use up more soil nitrogen than the plants give back. A legume, on the other hand, like clover, has enough nitrogen for the bacteria to use, plus an additional amount that is added to the soil. That's fundamental too.

In the South, though, there's one thing to watch out for. The hotter the climate, the quicker soil nitrogen disappears. So in the South it's advisable to plant another crop very soon after legumes are plowed under, so the nitrogen from the legumes can do the most good before it disappears.

Cover crops are the most important way of getting organic matter back on the land. The second most important way is by the use of farm manures. In the Yearbook, Robert M. Salter and C. J. Schollenberger, of the Ohio Agricultural Experiment Station contribute an article on that subject. These authors say a billion tons of valuable fertilizer and organic material is produced every year on American farms as a by-product of livestock keeping. But an enormous amount of this valuable material is lost because of the wrong kind of handling by farmers.

These authors give many practical pointers which I won't have time to take up here. If you read that article, you may find suggestions that will save you money and improve your land and your crops.

One other method of getting organic matter back into the soil is to use farm waste of all kinds -- straw, leaves, vegetable matter of any kind. Irvin C. Feustel, of the Bureau of Chemistry and Soils, has an article about this in the Yearbook. Some of this waste material -- straw especially -- should not be used fresh because it will almost certainly use up more nitrogen than it adds to the soil -- just like those non-legume cover crops I mentioned. But all waste can be stored in a heap somewhere -- a compost heap -- and by adding water and chemical fertilizers the process of decay can be greatly speeded up. A compost heap would not go very far on a whole farm, I'm afraid, but it can be very valuable for a vegetable garden or

other special uses.

This whole question of organic matter simmers down to this: Nature's methods of soil building have been successful for millions of years. That being the case, it looks as though we would be wise to follow nature's methods as far as possible. And that means feeding the earth with organic matter regularly and without fail!

So much for today. Next time we will take up the question of commercial fertilizers and lime.

#############

SOILS AND MEN

11. Food for Plant Growth

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture portion of the National Farm and Home Program, Monday, January 23, 1939, over 99 stations associated with the National Broadcasting Company.

--ooOoo--

KADDERLY:

Continuing the National Farm and Home program... from Washington.. we call upon Gove Hambidge.. Gove is editor of the Department of Agriculture Yearbooks. He's been meeting with us about once a week to make us better acquainted with the 1938 Year book... Soils and Men ... a book that Secretary Wallace has said endeavors to discover man's debt and duty to the Soil."

All right, Gove, if you'll just take up from where you left off last time... let's see.... you were at the point of discussing that very important matter of food for plants....

HAMBIDGE:

In some ways, cultivating the soil is like taming a wild animal. When a man tames a wild animal, he keeps it under artificial conditions, and if it is to stay healthy, he has to provide it with the kind of food it would have had under natural conditions. The soil under natural conditions would get plenty of organic matter first and foremost. Last week we discussed how to give the soil organic matter by the use of rotation and farm manures.

The soil may also be thought of as a rich storehouse of chemical foodstuffs or nutrients for plants. The plants suck up this foodstuff and build much of it into their bodies. When you harvest a crop, you take away all the chemicals those plants got from the soil. Some chemicals are also washed out of the soil by erosion. Unless you put these chemicals back, they're permanently lost from the soil.

Nowadays we put them back largely by using chemical fertilizers. We aim to keep the right balance of plant foods in the soil at all times. The three nutrients to which we pay most attention are nitrates, phosphates, and potash.

Now how do we find out how much of these elements a given soil and crop need? Modern chemistry has made this whole thing pretty much of a science, though soils men will tell you there's still plenty we don't know. In general, three methods are used to find out the fertilizer needs of a certain crop on a certain soil - the plot method, p-l-o-t, the pot method, p-o-t, and the so-called quick test. These three methods are described in an article in the Year book by Oswald Schreiner and M. S. Anderson of the Bureau of Plant Industry.

The quick test is the newest method. Probably you're familiar with it. Usually it consists in shaking up a measured amount of the soil to be tested with a measured amount of a certain chemical, then filtering the mixture or letting it settle. The color of the liquid or its cloudiness is then compared with a chart, and the chart tells you at a glance, almost, how much of a particular fertilizer element is needed according to the color or cloudiness of the sample. It's all over in a few minutes, comparatively. The method is not as simple as it sounds, though, because other things have to be taken into consideration as well as the results of the test. However, thousands of these quick tests are now being made for farms over much of the United States, and in the hands of experienced soils men they're useful - expecially if they're not taken too literally in terms of the exact number of pounds of fertilizer required.

Pot tests are usually carried out in a greenhouse. Plants are grown in a number of pots of sterilized soil or sometimes sands; then carefully measured amounts of different fertilizer elements are added to different pots. It's possible to make pretty close comparisons by this method, because you can see the actual effects on the plant when you leave out an element in one pot and add it in another pot, as will as the effects of adding different amounts.

Plot tests, p-l-o-t, are of course the old standby. Field plots are used for growing plants under pretty nearly natural conditions, and different methods of handling the soil and using fertilizers in different plots are compared over a period that usually lasts many years. In the past, probably most of the fertilizer recommendations from the experiment stations and elsewhere have been based on the results of work in field plots.

So much for the methods of testing. Now for the fertilizers themselves. There's an article in the Yearbook that takes up over fifty separate fertilizer materials one by one and discusses the pros and cons, the advantages and disadvantages, of each. It's by Albert R. Merz of the Bureau of Chemistry and Soils, and Oswald Schreiner and B. E. Brown of the Bureau of Plant Industry. Another article, written by William H. Ross and Arnon L. Mehring of the Bureau of Chemistry and Soils, deals with mixed fertilizers. Most farmers in this country use ready-mixed fertilizers, though in many cases they could mix the materials themselves if they wanted to t ake the trouble.

If your memory goes back to 1900, you'll remember that fertilizer prices were generally about twice as high then as they are today. There has also been a remarkable change in the materials used since the old days. Nitrates used to be gotten mostly from the huge deposits of guano left by birds in South America. Phosphorus used to be gotten mostly from ground-up bones. All that is changed today.

The biggest developments in the fertilizer industry in the United States came as a result of the World War. The war compelled us to work out methods of getting nitrogen from the air, because we had to have it for making munitions. After the war, these munitions plants turned to making fertilizer nitrogen in order to keep going. The war also made us develop our own potash deposits so we could be independent of European sources. Phosphorus we already had, Since there are big deposits in the Southeast and the Northwest.

The change in fertilizers in recent times has been principally the development of a long list of new materials. The advantage of these new materials lies partly or largely in the fact that they're much more concentrated than most of the old materials; that is, they carry a much higher percentage of actual fertilizer for a given amount of bulk. There have been other improvements, too, and in general they have resulted in greater economy. Still and all, our farmers spend some $200,000,000 a year for fertilizers, which is nothing to be sneezed at.

Mixed fertilizers can now be made so they're pretty free of the tendency to cake up, and the different elements stay well mixed together, without separating into different-sized particles. This makes for more even distribution of the chemicals, and that's important in avoiding fertilizer injury to plants. The mixtures too, like the separate elements, are more concentrated than they used to be. Low-analysis mixtures are pretty well out nowadays because they're uneconomical.

Here's an example from the Yearbook of how a farmer can save money on his fertilizer bill. Suppose he had been using a 3-8-3 mixture. - 3 percent nitrogen, 8 percent phosphate, 3 percent potash. This is a total of 14 percent of actual fertilizers in the total mixture - 3,8, and 3. But that farmer might just as well use a 6-16-6 mixture. The proportions of the 3 elements are the same, but the percentage of actual fertilizers in the total mixture is double what it was. Six, 16, and 6 adds up to 28 percent instead of 14. With the more concentrated mixture, the farmer doesn't have to freight on a lot of material that does not help to grow plants; and altogether, by doubling the percentage of actual fertilizers, he would save maybe a fourth of the cost - at least according to prices a few years back.

Next week I'll take up another point that means a saving in the fertilizer bill. And I guess that's all for today.

KADDERLY:

You know, Gove... I said you are meeting with us to make us better acquainted with this 1938 Yearbook of Agriculture... Soils and Men. That's true... but the really important thing is that in these once-every-week chats you are demonstrating that never before has so much information about the soil been placed between two covers.

And Farm and Home friends... all the information in the 1200 pages of Soils and Men is yours for the asking. You can get a copy of this Yearbook from your United States Senator or Representative....... free. Ask him for the 1938 Year book of Agriculture... Soils and Men.

This story on foods for plant growth by Gove Hambidge concludes the Department of Agriculture's participation on this N.B.C. network for today--- and we return you to Chicago.

#####

SOILS AND MEN

12. About Fertilizers and Lime

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture portion of the National Farm and Home Program, Monday, January 30, 1939.

--ooOoo--

Last week I was talking about how the fertilizer needs of various soils and crops can be quite accurately determined by experimental tests and trials, which are used as a basis for recommendations to farmers. We saw that fertilizers are a big item in the cost of production today, but the farmer can reduce his fertilizer bill by using modern concentrated materials and high-analysis mixtures.

He can also reduce the cost by proper placing of the fertilizers he uses.

Robert M. Salter, of Ohio State University, has an article about methods of placing fertilizers in the Yearbook. The old method of applying fertilizers was to broadcast it over the field. But in recent years a big experimental program was carried out by more than 20 State agricultural stations in cooperation with the Department of Agriculture - and the upshot of the experiments was that broadcasting turned out to be not so good. (I don't mean radio broadcasting, Wallace; I mean fertilizer broadcasting.)

According to these experiments, placing fertilizers in narrow bands, like ribbons, on each side of the planted seed has it all over broadcasting in most cases. For one thing, these bands put food right close to the young plant as soon as it begins to grow roots. In other words, the baby doesn't have to go look for the nursing bottle; it's handed to him. With food right close at hand, the young plant gets a good start and tends to mature earlier, which is a good thing in most cases.

How close to the seed should the fertilizer bands be placed? That depends on the amount of fertilizer you want to use per acre; on how sensitive the plant is to fertilizer injury; and on the texture of the soil. The distance from the seed may vary from as close as 3/4 of an inch to so far away as 2 1/2 inches. And the bands themselves may be as narrow as 3/4 of an inch or as wide as two inches.

Salter's article gives different recommendations for different crops - corn, potatoes, cotton, tobacco, sugar beets, small grains, vegetables, meadows and pastures, soybeans, field beans, and so on. And he points out that there's machinery available now for placing fertilizers by this band method.

(over)

Now lets go on to lime. The article on liming in the Yearbook is by Emil Truog, who is Professor of Soils at the University of Wisconsin.

Liming is almost always necessary in the humid regions. This is because calcium - which is lime - calcium in the soil is quite readily dissolved by water, and wherever there is a moderate to heavy rainfall the calcium gets gradually washed out - or leached out, as the soils men say - leaving the soil acid in reaction. In dry regions, calcium doesn't leach out of the soil to anything like the same extent; in fact, many dry-land soils have a layer of accumulated lime not far below the surface, and they never do become acid.

Now a good many, maybe most of our cultivated crops require a sweet soil - not actually alkaline in reaction, but around neutral or at the most only slightly acid. The reasons for this are pretty complicated and I won't go into them here. Anyway, too much acidity seems to affect plants much as it does human beings, leading to a number of different ills.

Correcting soil acidity is a comparatively simple matter, but you have to take a little trouble and spend a little money for lime. Truog suggests that it's a good idea to use a soil-testing kit and go over the whole farm, testing the soil not only in every field, but even in parts of fields. Then sketch out a rough map showing the soil reaction of each area. Instead of applying the same amount of lime over the whole farm, you can then figure just the amount needed in each area to bring the soil to the right point. After you've once corrected the acidity, it's simply a question of using enough lime each year to keep the soil reaction at the right point. Truog calls this "balancing the lime budget."

Apparently not a single State in the East or South uses enough lime to keep its soil at the right point. Take Wisconsin as an example. Truog says it would require 15,000,000 tons of ground limestone right now to bring the soil in Wisconsin up to the proper level. After that, however, it would take only one million tons a year to keep the proper level. Ths cost per acre of the whole operation would be comparatively little - and worth the price. Truog believes that if farmers could get lime cheaply enough,we would use a lot more of it than we do.

And now I've come to the place where the Yearbook takes up another big subject - erosion control.

I was talking with an old friend who has farmed a small place for many years in a hilly region in the East. The question of erosion came up.

"Tell me," he said, "what <u>is</u> erosion, anyway?"

Well, good heavens -- I thought. Every agricultural agency has been talking about erosion for years, and yet this man doesn't even know what it means. That's pretty discouraging.

So I explained that erosion is simply the washing away of unprotected soil by rain and melting snow. All sloping land is subject to erosion, but some types of soil stay put much better than others. And I suggested that my friend ought to read the article by Hugh Bennett, Chief of the Soil Conservation Service, in the Yearbook.

Hugh Bennett's main interest in life is controlling erosion. He writes about it, talks about it, and probably dreams about it. As a result, he's a crusader for saving our soil from this menace.

In this Yearbook article he tells what erosion is and what it does -- how the water may start by washing away the soil in thin sheets; then little rills develop, cutting the earth with a thousand tiny rivulets; and finally, on some soils, you get enormous gullies, as though the earth had been dug out by a giant steam shovel. But erosion also occurs on absolutely level land, without any water. That, of course, is in dry areas, where high winds pick up the surface soil bodily and sweep it away in huge dust clouds.

You don't always see erosion working. On a comparatively gentle slope it may quietly remove the soil bit by bit, like a thief who has plenty of time for his job. But whenever erosion takes soil away faster than nature can build it up, then there's going to be serious damage in the long run. And no amount of fertilizer will repair the damage.

How can this erosion process be stopped, or at least reduced to a minimum? That's the question we will take up when we get together next time.

###

SOILS AND MEN

13. How Can Erosion Be Stopped?

By Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the National Farm and Home Program, Monday, February 6, 1939, by the National Broadcasting Company and a network of 99 associated radio stations.

--ooOoo--

Last week we discussed the new methods of placing fertilizer in bands instead of broadcasting it and we also got into the subject of using lime. I believe I had just started to talk about Hugh Bennett's article in the Yearbook when it was time to quit. You will remember that this article is about the general aspects of erosion control First Dr. Bennett describes what erosion is and what it does to the land. Then he takes up the question of how it can be stopped -- or if not completely stopped, at least reduced to a minimum.

There are two general methods to reduce erosion damage. One is to use a cover of vegetation. The other is to use mechanical devices, that is, terraces and ditches and dams and so on. I suspect that in most cases, in practical farming, both methods have to be used together.

Now erosion, isn't any new thing. It's been going on ever since the earth was made, as a matter of fact. But under natural conditions, two things happen. First, most soil has its natural growth of plants, which protect the earth. Second, all those plants eventually decay right on the ground. We've seen that this decaying organic matter keeps the soil loose and light, so it will soak up water like a sponge. So even erosion does occur under natural conditions, it's usually a very slow process. Usually the soil keeps on building up as fast as it washes away, and in many places even faster.

But in order to farm the land, this natural cover has to be destroyed. In fact, a good deal of soil is kept bare much of the time, either between the rows of cultivated crops, or after one crop has been removed and before another grows up to take its place. Finally, the farmer doesn't put back anything like the amount of organic matter that nature puts back into the soil.

So we're back to the same point we took up in one of our previous discussions. Then we emphasized rotations and cover crops to keep the soil in good condition. Now we have to emphasize rotations and cover crops again as a means of preventing erosion. I doubt if there is any rule for erosion control half as important as these six simple words: Keep the soil covered with plants.

(But it's a poor rule that doesn't have exceptions. There is an exception to this one too. In dryland farming it's often better, after

(over)

a crop is removed, to leave the soil fallow, broken up into rough clods, than to try to put in a cover crop. This is only because there's so little moisture in the earth that a cover crop would use it all up.)

All right, a covering of plants is important. Now what kind of plants should be used? That all depends. Where the land is very steep, or where it has already been eroded down to subsoil, or where it has been abandoned and will stay abandoned indefinitely, the safest cover may be trees. Put such land into forest or into a woodlot. That goes for odd corners on many a farm, and for bad gullies, as well as for larger areas. There's an article in the Yearbook on the use of trees for erosion control, written by E. N. Munns, John F. Preston, and Ivan H. Sims, of the Forest Service.

Cutting the forests clear has caused a lot of unnecessary erosion in this country. Now we find we have to put some of those forests back again in order to save our soil. We human beings do like to make work for ourselves.

I learned from this article on forests for erosion control that it's not the network of tree roots that holds the soil in place, as I used to think. The principal thing is the thick carpet of dead leaves and so on. This decaying matter builds the kind of soil that can soak up plenty of water. And the thick canopy of leaves overhead prevents rain from hitting the ground with the force of a million little sledgehammers and literally knocking off little pieces of soil.

Some land that is subject to serious erosion can be put permanently into grass or other thick-growing vegetation. Such a permanent cover is for severe cases where a major operation is needed. And speaking of operations -- even after a successful operation, a patient will sometimes get an infection and die. Similarly, if you put land into good perennial grass and then destroy that grass by overgrazing, the soil is going to erode anyway.

On most farms very little land, comparatively speaking, has to be retired from cultivation permanently. The soil can be protected enough by using temporary cover crops in rotation with cultivated crops. This whole question of using either grass or some other thick-growing crop for erosion control is discussed in one of the Yearbook articles, written by C. R. Enlow and G. W. Musgrave of the Soil Conservation Service.

One of the best ways to use these thick-growing plants on sloping land is to have them in strips, alternating with strips of cultivated crops. First there's a broad strip of a cultivated crop, the width depending on the slope and the rainfall and the soil. Then comes a strip of a thick growing crop, maybe a grain or a legume. Then another strip of cultivated crop. And so on up the slope.

These strips have to follow the true contour of the land pretty exactly -- not more than 2 percent of the contour is the usual recommendation. That means that you first have to lay out an accurate guide line following the contour. Then you can measure off on both sides of this guide line to mark the strips. The plowing of course, is all done on the contour too.

Last summer, down in South Carolina, I went over several farms that were terraced and strip-cropped. First there would be a strip of cotton, then a strip of grain or maybe lespedeza, then another strip of cotton, and so on. What the strips of thick-growing crops between the cotton do is to stop water from running any farther and give it a chance to soak in. The thick-growing strips can be used in a regular rotation with the cultivated strips, and they have all the advantages of any rotation.

Walter V. Kell, of the Soil Conservation Service, has an article about strip-cropping in the Yearbook. Soil-conservation people say that in some parts of the country it's the simplest and easiest way to help prevent erosion.

Well, I see it's now time for me to finish. Next time we'll go on with some other methods of erosion control that are taken up in the Yearbook.

###

SOILS AND MEN

14. More about Erosion Control

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, Monday February 20, 1939 in the Department of Agriculture period, National Farm and Home Program.

--ooOoo--

The last time I was on this program we began discussing erosion control, and I took up the methods that involve the use of trees, grass, legumes, rotations, and strip-cropping -- what are called vegetative methods. Today I want to consider the so-called mechanical methods of erosion control.

In these mechanical methods, you are trying to do one or both of two things. First, you are trying to hold the water on the soil long enough for it to soak in instead of running off. Second, you are trying to lead excess water off of steep slopes in such a way that the soil will not be damaged -- which is like putting fire escapes in the upper stories of a school so the pupils can get out in an orderly way in case of fire.

Terraces and channels are the main things used for both of these purposes -- both to hold all the water that will soak in and to lead off the excess. Now you can terrace sloping land in two ways -- either by leveling it in a series of steps, or by throwing up a ridge or embankment of soil part way down the slope. The first method, leveling off the land in steps, is called bench terracing. Bench terracing ordinarily requires so much labor -- my whole garden is bench-terraced by hand, my own hands, so I know -- I got lumbago doing it -- that it's too expensive to use except where level land is very scarce and the crop is very valuable. The ridge or embankment method is cheaper and easier because much less dirt has to be moved. In this method, you can either have just a ridge, which holds back the water, or you can have a ridge with a broad, shallow channel on the upper side of it. This channel follows a gentle, regular grade along and down the hill and takes off excess water very slowly.

Sometimes the channel down the slope is so broad that it becomes a meadow in itself. Then it is called a meadow strip, and it can be used to drain quite a large area.

All channels that are intended to lead water off slowly have to be planted to some permanent, thick-growing crop, usually grass.

These are the simplest points about mechanical devices for erosion control. There's a lot more of it, as you know from some of the radio programs the SCS has been giving on this same subject. The whole subject is discussed in detail in a Yearbook article by M. L. Nichols and T. B. Chambers, of the Soil Conservation Service.

I doubt if any of these methods of erosion control is really very new; most of them have been used by farmers here and there for a long time. But there is something new in our modern approach to this problem. First, we make a more exact determination of what is needed for adequate erosion

control today, and second, we almost always use a combination of methods instead of just one. No one method alone will do the trick on practically any farm where erosion is a real problem -- and that's important to keep in mind. In one of the Yearbook articles, Irvin J. Utz, of the Soil Conservation Service, tells how several methods have been tied together on some actual farms that are typical of different parts of this country. The whole thing reminds me of the strategy of a battle. And in fact it is a battle, against one of the most powerful and destructive of natural enemies, erosion.

Now it's true that some types of soils are less subject to erosion than others, but it's a fairly safe rule that all sloping land, unprotected by a thick growth of plants, is going to have soil carried away by water, either slowly or rapidly, depending on the slope. Even land as flat as a pancake is subject to erosion, wind erosion, in the dry regions. If this erosion is neglected, it often becomes a very serious menace. Millions of tons of good American soil have already been washed away, and many more millions of tons will be washed away, unless something is done to stop it.

What the experts emphasize today, it seems to me, is that you can't fight this menace by just pecking away and doing a little dab of something here and another little dab there. If we don't want to see a whole lot more of our precious topsoil just disappear from under our eyes, taking all the fertility along with it, we have to understand the forces we're up against and combat them with as much strategy and knowledge as - well, as modern medicine uses in combatting plagues. Erosion is a plague, but we don't have to have it any more than we have to have smallpox. But if you want to escape smallpox, you have to take the proper precautions.

It's not simply a matter of devices, either. All good soil management helps to prevent erosion. If you use an adequate amount of phosphate fertilizer, and in humid regions an adequate amount of lime, you encourage vigorous plant growth - and vigorous plants help to prevent erosion. If you follow a good rotation system, keep a fair percentage of the land in thick-growing crops, and put a good deal of organic matter back into the soil, that helps to prevent erosion. If you keep pastures and range land conservatively stocked and don't overgraze them, you're helping to keep both the soil and the animals in prime condition.

In other words, don't think of erosion control as some separate and peculiar problem. It really isn't. It's simply a part of the whole business of good soil management.

Before leaving this subject of erosion control, I'd like to go briefly over some of the main points mentioned. The first and simplest preventive measure is to plow on the countour instead of merely across the slope, or -- which is much worse - up and down hill. The next simplest preventive measure is strip-cropping - planting row crops and thick-growing crops in alternate strips, following the contour. After that you get into more elaborate methods, like terracing to hold water back and various kinds of ditches or channels - to make the water walk off instead of run off, as I believe Secretary Wallace once put it. Finally you have still more elaborate

methods like impounding water with weirs and dams.

Different farms need different combinations of these methods, and every farm should be considered as a problem by itself. But practically always the main line of defense, whatever else you do, is a good vegetative cover and plenty of organic matter in the soil. Some soils and some slopes are so bad that they have to be put permanently into this vegetative cover-grass or trees - not only to protect that piece of land but other land below it, which may be much more valuable.

Understand the soil and give it a chance. It will then go a long way toward protecting itself.

That's as far as we can go today. Next time we will take up a few special areas and problems in soil management in this country.

###

SOILS AND MEN

15. Some Special Problems in Soil Management

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, in the Department of Agriculture period, National Farm and Home Program, Monday, February 27, 1938.

- - O - -

After the discussion of methods of erosion control last week, I said that today I would take up some of the special areas and the special problems in soil management considered in the soils Yearbook.

Farming in the dryland areas is one of them. There's an article about that in the Yearbook, written by O. R. Matthews and John S. Cole of the Bureau of Plant Industry.

Now a good deal of soil out in the dry areas is extremely fertile down to a great depth. This soil has been built up by ages of the slow decay of a heavy grass cover and grass roots. At the same time, there was not enough rain to leach out the accumulation of chemicals - which is what often happens in our more humid regions. Some of the dryland soils certainly have what it takes to grow wonderful crops.

But in this business of farming, it seems to me, there's always a fly in the ointment somewhere. On these rich dry lands the limiting factor is moisture - and that's a whale of a fly. Dry-farming becomes a question of matching your wits against the weather. It's more of a gamble than most farming, and the chances are against you unless you know exactly what you're doing. You have to be able to take advantage of every drop of moisture that gets into the soil, and you have to know when there is not enough to make a crop.

In other words, there must be a certain amount of moisture to get any paying crop at all, and anything less than that means failure. On the other hand, anything over that is - pure velvet. Within the past few years simple methods have been worked out, for at least parts of the semiarid region, by which you can test the soil, before planting with a soil auger or even a spade. If the moisture proves to be below the danger line, don't plant say the experts; you'll only lose money. If the moisture is around the danger line, you may get by. If the moisture is well above the danger line - go to it; the weather is with you that year.

These tests take some of the gamble out of dry-farming. In addition, there are certain ways to make the most of all the rain there is. For instance, some tillage methods enable the soil to take up more moisture than others. Level terracing may be done in some places to hold water on the land. In a dry year when planting is unsafe, the land can be left idle, fallow, and that will help to save up some moisture for the following year. All weeds can be kept down, because weeds use up a lot of water. And finally, some crops are like camels - they can get along with very little water - and they're the ones to grow.

(over)

But even with all that, there's still a fundamental question to be decided for each particular area. Is it really suitable for growing crops? Some of these dry areas might much better be left in grass and used for livestock-farming.

Another special problem in soil management - irrigation farming. Here again, the richness of the soil in dry regions is what makes large-scale irrigation profitable. But it is not true that all you need is to get water onto the land. That's a fallacy, and it has led to some bad mistakes.

There are three articles in the Yearbook that deal with some practical aspects of irrigation - one, by Wells A. Hutchins, M. R. Lewis, and P. A. Ewing of our Bureau of Chemistry and Soils; another by C. S. Scofield of the Bureau of Plant Industry; and a third by James Thorp, of the same Bureau in collaboration with Scofield.

One of the biggest irrigation problems, as I understand it from these articles, is this. In these dry soils, you already have a large supply of certain chemicals, built up over a long time. Then you bring water onto the land, water that maybe came originally from a long distance off. That water is also loaded with chemicals, which it picked up along the way. The result is that you get too much of a good thing - like eating too much strawberry shortcake, which they tell me is possible, though I've never succeeded in getting too much yet. The soil gets a sort of - acute indigestion. Its whole structure may gradually change for the worse, or the plants growing in it may be actually poisoned.

There are three principal steps in preventing this kind of thing. First, the experts should know all about the soil to be irrigated and just how it's going to act under irrigation. Second, they should make sure that there's not only enough water for irrigation but the right kind of water from the chemical standpoint. Third, they should provide adequate drainage to get excess water off the land after the crop has been watered. If this excess is properly drained off it will take surplus chemicals along with it, and they will not keep on piling up in the soil.

While we're on this subject of drainage, I might bring in the more common kind we're all familiar with here in the humid regions - that is, draining wet land with open ditches or underground tiles. Drainage is a necessary part of good soil management on many farms and John R. Haswell, of Pennsylvania State College, has an article about it in the Yearbook. He pays particular attention to tile drainage - which is usually better than open ditches in the long run - and he tells about the different systems that can be laid out, how to lay the tiles, and a lot of other practical points. Tile drainage is quite an expensive business, as every farmer knows, and if you don't do the job right in the first place you may just be throwing your money away.

Let me emphasize one point here - In the past, there's been some enthusiastic but unwise drainage of muck and peat land in this country, on which everybody lost money in the long run. Better think twice before draining any large area of this kind. Then, to be safe - think a third time.

Now just one more special soil management problem - the management of forest soils. This subject is covered in a Yearbook article by Ivan H. Sims, E. N. Munns, and John T. Auten, of the Forest Service. I'll mention just one point that concerns many farmers in the East who have woodlots. Should the woodlot be grazed by farm animals? This is a very common practice - but according to these forestry people, it's all wrong. For instance - experiments in Wisconsin show that grazed woodland loses about 100 times as much soil and 60 times as much water as woodland that is not grazed. The advice is to fence off the woodlot if possible and pasture animals on pasture, not in the woods. It's a different matter, of course, out in the big western forests, where grazing is only seasonal and is carefully managed.

Well, I guess that's all for today. Next time we're going to leave this broad subject of soil management and go on to the subject of soil science.

# # # #

SOILS AND MEN

16. From the Soil to the Plant to the Animal

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, Monday March 6, 1939, in the United States Department of Agriculture period, National Farm and Home Program.

--ooOoo--

Today we're going to take up a new section, Part 3, of the soils Yearbook, so, just because I have an orderly mind, I want to remind you very briefly of the subjects we have already covered in these talks.

You will remember that the first part of the Yearbook deals with the Nation and the Soil--the broad economic and social aspects of soil use in this country. In the talks at the beginning of this series, we tried to put our finger on some of the--well, economic causes of soil misuse--or socio-economic causes, if you want to be--more highbrow. We found that these causes range all the way from individual lack of knowledge to great depressions that put pressure on all farmers to squeeze as much as they can out of the land--whether it's good for the soil or not. And we considered some of the remedies that are being tried to solve these difficulties.

Next, we took up Part 2 of the Yearbook, which deals with the Farmer and the Soil. There we considered practical questions of soil management. We emphasized especially the common deficiencies of soils that have to be corrected--corrected by a liberal use of organic matter and fertilizers; by crop rotations; and by the use of cover crops and farm manure. We also discussed a good many other questions, especially how to control erosion.

In discussing soil management, I tried to emphasize five things particularly--organic matter--(Some people probably think I have organic matter on the brain)--crop rotation--phosphorus--and lime in the humid regions). That's four things. The fifth is this. Erosion is a powerful enemy. Don't try to fight it with an old-fashioned blunderbuss or bow and arrow. Use the weapons of modern science.

Now, let's go on to Part 3 of the Yearbook, which deals with the scientific background of all this economic and practical material. Here we'll be discussing the nature of the soil and why it has to be handled properly to get results.

First of all, what are the soil requirements of the plants we grow for food and other uses? That's a fundamental question. From the practical standpoint, every farmer answers it when he grows certain crops on his soil and does not try to grow others. He knows his soil suits the requirements of those crops.

This question of the soil requirements of plants is taken up in an article in the Yearbook written by M. F. Morgan of the Connecticut experiment station, J. H. Gourley of the Ohio station, and J. K. Ableiter of our Bureau of Plant Industry. They consider some forty or more different crop plants grown in the United States and summarize what is known about the soil requirements of each of them. Naturally I can't go into those details here. I can just--skim over some of the broadest points.

(over)

Here's what you have to have if a soil is to grow any crops at all. The soil must be suited to the use of efficient cultural implements; some perfectly good soil for instance, is too full of stones to be cultivated efficiently. The soil must offer resistance to destructive erosion; if it does not resist erosion naturally, you have to manage it so it will. The soil must be capable of storing up enough moisture to meet crop requirements; if it doesn't, you may be able to improve its moisture-holding capacity by good management. There must be enough air in the soil to permit the development of a good root system; waterlogged soils, for example, do not give roots enough air. There must be enough nutrients in the soil to nourish plants; if there aren't enough, you have to provide them. And finally, the soil must not be chemically unbalanced. It must not be too acid or too alkaline, or have too much of some substance harmful to plants.

In a nutshell, the soil has to have--enough water, enough oxygen, and enough plant food to grow any crop. After that you can begin to consider the special requirements of different crops.

Now let's turn to another aspect of this subject. An article by C. A. Browne, of the Bureau of Chemistry and Soils, deals with what might be called the principal chemical nutrients in the soil--nitrogen, phosphorus, and potassium--and their relation to the health, not only of plants, but of the animals that feed on the plants. For instance, suppose we take a soil that is very deficient in phosphorus. Not only will the plants grown on that soil suffer in certain definite ways; the animals will also suffer if they have to eat those plants exclusively.

As a matter of fact, there are such phosphorus-deficient areas in the United States, and in other parts of the world. Cattle grazing on the plants in those areas do have serious diseases unless the condition is corrected. The cattle cannot get enough phosphorus to build their bones or to keep them healthy. They try instinctively to make up for the deficiency, and sometimes in such areas you will see cattle going around looking for bones to gnaw as though they were hound dogs.

This question of the relation of animal nutrition--and even human nutrition--to the soil--it's a new field of investigation, and not a great deal is known about it as yet. We are getting a little better understanding of the relationship between the chemicals in the soil, the chemicals in the plant, and the chemicals in animal and human bodies. As a matter of fact, everything you eat has to come from the soil, originally. Plants are nothing but the agents that take raw chemicals from the soil and fix them up for your mourishment. Even if you lived on a meat diet exclusively, the animals that furnished the meat would be living on plants. Fishes either live on plants that grow in the sea, or on other fishes that live on plants. And the chemicals that nourish plants in the sea came originally from the land. So all life goes back to the soil, literally. Every hair on your head and every cell in your body was built out of something that came originally from the soil. And plants brought it to you either directly or in some roundabout way.

Well, that's a big subject--and--I'm afraid I can't say any more about it today. We'll go on with it the next time we meet on this program.

SOILS AND MEN

17. Some Mysteries Explained

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture portion of the National Farm and Home Program, Monday March 27, 1939 over 104 Stations associated with the NBC Blue Network.

--oOo--

The last time we got together on the air, the discussion ended with a brief account of how an abundance of certain major chemical elementals in the soil, or a lack of them, affects not only plants but animals and human beings. The reason is that plants get their food from the soil; then all animals and human beings get their food from plants, directly or indirectly.

We considered only a few chemical elements that are generally thought of as the most important for plant growth. But they're not by any means the only ones. In fact, the scientists have been finding more and more elements that are needed by plants. These scientists have made another interesting discovery. Some of these elements are needed by plants only in very minute traces, so small you can hardly measure them. In slightly larger quantities, some of these elements become poisonous and may even kill the plant. This is a curious situation. Unless the plant gets a tiny bit of such a substance, it sickens or dies. But if it gets a tiny bit too much, it also sickens or dies.

One of the elements necessary in very small quantities is boron - the basis of ordinary borax powder and borax soap. Another is copper. Another is zinc. And here's another discovery. Certain plant diseases that were complete mysteries a few years ago have now been found to be due to the lack of one or another of these chemicals in the soil. For instance, the once mysterious disease of tobacco called sand drown has now been found to be due to a lack of magnesium in the soil. A disease of pecan trees called pecan rosette has been found to be due to a lack of zinc in the soil. A disease of sugar beets called dry rot has been found to be due to a lack of boron in the soil. And so on. Very often these diseases can now be cured simply by giving the plant a little of the necessary chemical -- just as we can cure scurvy by giving people vitamin C.

These are new developments and they are covered in an article in the Yearbook by J. E. McMurtrey, Jr., of the Bureau of Plant Industry, and W. O. Robinson, of the Bureau of Chemistry and Soils. These authors take a list of 36 different chemical elements that are found in soils and tell what is known about the relationship of each of these elements to plant growth, and whether it has effects that are good, bad, or indifferent. You must remember that in the case of many elements comparatively little is known as yet. The research work is very delicate and difficult, too, because the quantity of some of the elements is often so extremely small -- but I think it's a fascinating field for experiment.

(over)

One element that is poisonous to animals as well as to many plants gets a special article in the Yearbook. That is selenium -- a name that comes from Selene, the Greek word for the moon. K. T. Williams, of the Bureau of Chemistry and Soils, tells how, away back in 1857, some cavalry horses in a certain part of what was then the Territory of Nebraska got a mysterious and deadly disease. Well, for the next 75 years cases of this disease, which people called alkali disease, kept cropping up among horses and cattle, but nobody could discover what caused it. Some thought it was the pasturage. Some thought it was the water the animals drank. It wasn't until 1928 that scientific investigators began experiments that finally pinned the disease onto selenium, which plants around there took from the soil. Animals eating those plants lost their hair and hoofs, they got lame, they swelled up with dropsy. Sometimes they were dead in a few hours.

Well, it was found that selenium is present only in soils that come from certain geological formations, and that as little as one part of selenium in a million parts of soil can produce forage plants that are poisonous to grazing animals. Fortunately there are only a few limited areas where even this much selenium stays in the soil, and those areas are in dry country. In a moister climate, the selenium gets washed out of the soil so it can't do any harm. And finally, animals apparently tend to avoid the poisonous plants except when they're driven to eating them because the range has been overgrazed.

So there's another example of the relationship between soils, plants, and animals.

The relationship between plants and the soil shows up very strikingly in the case of native or wild vegetation. Certain plants tend to come in on certain soils; then they decay, and in turn those particular plants affect the character of the soil. Some of the old-time pioneers used to be able to tell a good deal about what a piece of soil was good for by the kinds of plants that grew on it, and modern soil surveyors still use this method to some extent.

The whole United States, in fact, can be divided into a few broad regions, each of which has certain characteristic native plants. There are the regions of deciduous forest; of mixed forest; of coniferous or evergreen forest; of juniper woodland; of tall grass - the prairie; of short grass - the plains; of mesquite grass - the desert; and of desert sagebrush and creosotebush. These broad regions in turn can be divided into smaller areas according to their vegetation. If you made a map of the regions of natural vegetation and then laid it on top of a soils map, you would find that certain kinds of plants and certain kinds of soils generally go together.

H. L. Shantz, of the Forest Service, has an article about that in the Yearbook. He shows that if you are wise in these things, you can tell, by the native vegetation, whether the climate is cool or warm; whether the rainfall is high or low; whether droughts are frequent; whether the subsoil is permanently dry, or moist, or flooded; whether the land is better

for crops or for grazing; and on western raw lands, whether the soil is good, medium, or poor for small grains or forage crops, and roughly how many head of cattle it will carry when it is used for range.

Well, I've been talking about the soil for some weeks or months now, and we haven't yet asked ourselves the question - what is soil, anyway?

Some people would say that soil is dirt; it's earth. But that doesn't tell us very much. What's it like when you examine it closely?

I'll begin trying to answer that question next time, when I plunge into the subject of soil physics and chemistry. No - let me say that over again. I won't plunge into physics and chemistry. I'll wade in, rather gingerly. It's a deep subject, and I don't want to get over my head.

* * * *

SOILS AND MEN

18. What Is Soil?

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, Monday, April 3, 1939, in the Department of Agriculture portion, National Farm and Home Program.

--ooOOoo--

The discussion on this program a week ago ended with a question - what is soil anyway? To answer that question, we have to deal with two rather difficult sciences, physics and chemistry. At least they seem difficult to me because I've never been what you'd call a shark at either one of them. And for that reason I'm just going to tell you some outstanding impressions that remain in my mind about soil physics and soil chemistry.

There are three articles in the 1938 Yearbook that give the information I'm going to skim over here. One is on the physical nature of soil, by T. D. Rice and L. T. Alexander. One is on the water relations of soil, by L. B. Olmstead and W. O. Smith. And one is on the chemistry of soil, by Horace G. Byers, M. S. Anderson, and Richard Bradfield. All of these men are scientists in the Department of Agriculture except Professor Bradfield, who is at Cornell University.

And now for those outstanding impressions.

If you dig very deep into the soil - in making a trench or well, for instance - one of the things you can't help noticing is that it lies in distinct layers. We might as well call these layers by the term soil scientists use, which is horizons. I don't know why they use that term rather than layers, but they do. Scientists have a language all their own, and sometimes the words they use have a different meaning in everyday language -- which makes it a little confusing to the rest of us. But anyway -- these layers, with which every farmer is familiar, are soil horizons in the lingo of the scientist.

The top layer may be only a few inches or it may be two or three feet deep. It has a different color and feel than the lower layers. This top layer is the A horizon, and it's where life is most abundant in the soil - such life as plant roots, bacteria, fungi, insects, and so on. The A horizon is also the layer usually cultivated for crops.

Down below the A horizon is the B horizon - which most of us commonly call the subsoil. This B horizon is often heavier than the A horizon, and it often contains much more clay. The A horizon and the B horizon together make what soil scientists call the true soil. By this they mean that physical forces, chemical forces, and biological forces have all been working in these two horizons long enough so that the material in them isn't at all like what it was in the beginning. It's been changed completely, and the changes are what give it the power to sustain life. and make it true soil.

(over)

Below this true soil is a third layer, the C horizon, which hasn't yet been turned into true soil. This C horizon is called the parent material of soil. Parent material is material that has undergone some change from the original rock, but not enough to make it true soil.

Well, these are the three principal horizons, A, B, and C, but in many soils some of them can be divided into distinct parts, which are called A_1, A_2, B_1, B_2, and so on. All the horizons together, from top to bottom, make what the scientists call the soil profile. That word profile is another common word used in a special sense. It makes me think immediately of the profile, the side view, of a person's face - forehead at the top, then nose, then mouth and chin.

All right, let's carry that comparison a bit further. You can tell a pure Caucasian or Chinese or Negro by looking at his profile. Within these races, you can sometimes tell what nationality a man belongs to by looking at his profile. Within the nationality, you may be able to tell what family he belongs to by certain family resemblances. But finally you get down to the individual differences that make a man's face entirely his own.

Broadly speaking, the same kind of thing is true of soils. One of the first things a scientist does when he examines a soil is to look at its profile. He can then decide - well, it's a loose comparison, but I'll say he can decide what race, nationality, and family that piece of soil belongs to, and with this information he can tell you a lot about it.

Now a close examination of the soil shows that it isn't all solid earth. It really consists of countless numbers of particles, of different kinds and sizes. Some of the particles are fragments of rock, which range in size from gravel down to sand and finally down to the finest clay. Some are bits of decayed organic matter. Different soils have different proportions of coarse and fine particles, and this is what gives each soil its characteristic texture or feel. Some soils are coarse and gritty, some are smooth and silky, and so on.

But these particles aren't by any means all separate. Usually several particles, sometimes a great many, are stuck together in little lumps, and sometimes the particles stick together so hard that it's difficult to separate them by squeezing the lump in the fingers.

This may seem like a small point to notice. Actually it's one of the most important things about the soil. The size, the shape, and the hardness of those little lumps has a lot to do with the productivity of the soil, and a great deal of the farmer's work is for the sole purpose of getting the right kind of little lumps and not getting the wrong kind. For instance, if you cultivate some soils when they're wet, you break down all the little lumps and get a sticky mess that is like cement when it dries out. One reason why soil that has been in grass or legumes is productive is that it is naturally divided up into the right kind of little lumps.

Again the scientists have a word for it. Just as the particles make the texture of the soil, so these little lumps make the structure of the soil.

Why are the lumps so important? Largely because, as I said a moment ago, the soil is not all solid earth. A large part of it is air, trapped in millions of tiny spaces. Another large part is water, also trapped in millions of tiny spaces. When you walk on solid earth, you're literally walking on air, and you're also walking on water. And the spaces that hold the air and water lie within the lumps and between the lumps. The air moves through these spaces almost as though the soil breathed. Water trickles and moves in and around the lumps almost like the blood flowing to every part of your body. Millions of sensitive root tips feel their way among these spaces, almost as you would feel your way around a room in the dark, holding out your hands to touch the furniture.

Well, so much for some of the main characteristics of soil. I want to go on with a little more detail, but I'm afraid that will have to be left until next time.

##

NUTRITION AS A NATIONAL PROBLEM

Address by Gove Hambidge, Principal Research Writer, United States Department of Agriculture, before the Sections on Agricultural Economics and Home Economics, Association of Southern Agricultural Workers, New Orleans, La., February 2, 1939.

- - -

It is rather customary for speakers coming to the South to talk about the South, either as God's chosen country or as the Nation's number one economic problem or both in the same breath. I hope you will excuse me if I break this honored tradition. I was asked to talk about nutrition as a national problem and I shall stick closely to that theme, with the emphasis on the word national. Not a word will you hear about the South -- no comfort, no blame, no advice. So far as this particular discussion is concerned, East is West and South is North, and they meet in a common objective.

One other point. The factual material in this discussion -- not necessarily the opinions -- comes from contributors to the 1939 Yearbook of Agriculture, which will be out later in the year and will deal with the subject of animal and human nutrition in considerable detail. As editor of that book, I have taken the liberty of stealing some of the authors' thunder.

Let me take as a text this quotation from a presidential address before the American Medical Association made by Dr. James S. McLester a few years ago:

"In the past, science has conferred on those people who availed themselves of the newer knowledge of infectious diseases better health and a greater average length of life. In the future it promises to those races who will take advantage of the newer knowledge of nutrition a larger stature, greater vigor, increased longevity, and a higher level of cultural attainment. To a measurable degree, man is now master of his own destiny where once he was subject only to the grim hand of Fate."

In that short paragraph Doctor McLester hit an important nail squarely on the head.

Assuming that all of us here want America to be among those nations that will take advantage of the newer knowledge of nutrition, which does truly promise greater physical vigor, longer life, and better mental powers than we now have <u>on the average</u>, there are three questions we have to answer.

Question 1. What do people need in order to be well nourished?

Question 2. Do we Americans <u>as a whole</u> actually get what we need?

Question 3. If we don't, how can we get it?

<u>What Do We Need to Be Well Nourished?</u>

As you nutritionists know, that first question -- What do people need in order to be well nourished? -- involves a thousand intricate details about vitamins, minerals, amino acids, fats, carbohydrates. In a brief talk I shall have to skip these completely. You know too that there is no absolute certainty or agreement on all the details of what human beings do need in order to be well nourished. Such quantitative standards as have been set up for the various nutritive elements are almost all tentative and more or less open to question, with the notable exception of energy requirements, expressed in calories.

But though these standards are undoubtedly subject to modification with further research, they do have real meaning. If they did not, Doctor McLester could never have made that confident statement I have quoted as a text.

These standards have enough meaning so that Doctor McCollum of Johns Hopkins has been willing to commit himself to a very simple statement of what people need in order to be well nourished. He suggests the equivalent of a quart of milk a day throughout life; a liberal serving of greens or potherbs every day; and the equivalent of two salads containing raw fruits or vegetables every day. If you get those three things, says Doctor McCollum, you can eat what you like to make up the rest of your food needs.

Doctor Sherman of Columbia also commits himself to a very simple statement. He suggests that we ought to get at least half of our food calories in the form of the so-called protective foods -- milk and its products, fruits, vegetables, and eggs; and that at least half of the grain products we eat -- which would make up a considerable part of the remaining calories -- should be made of whole grains.

Neither of those suggestions attempts to deal specifically with what people can afford to buy. Doctor Stiebeling, of our Bureau of Home Economics, tackles the problem from that angle. She suggests four broad dietary plans suitable for different income levels.

One of these plans, the most economical, meets our needs for the various nutritive elements, as these needs are now understood, with some, but not a wide, margin of safety; you might say it is just above the danger line, and anyone who goes below that plan risks malnutrition. The next plan has a better margin of safety for proteins, minerals, and vitamins, and the next two plans have a wide margin. A wide margin of safety is essential just because nutritional standards are still tentative. In driving along a road in an automobile, if you don't know how sharp the next curve is or what is around it, you drive cautiously and stick well on your own side of the road.

At the higher levels of expenditure, these dietary plans naturally permit greater variety and tastier foods as well as an increasing margin of safety.

This method of approach is realistic and extremely useful. Sherman's and McCollum's suggestions approach standards for what might be called optimum nutrition as it is at present understood. So do Stiebeling's top dietary plans. Her suggestions for people with limited budgets are not nearly so generous, but they are carefully and conservatively calculated.

For instance, at the most economical level Stiebeling outlines a fair -- not a good -- diet that includes a pint of milk a day for children and expectant and nursing mothers, and 1/2 pint for other adults; about 3/4 of a pound of fruits and vegetables a person a day (exclusive of potatoes), of which about half are to be leafy or green or yellow vegetables and about a sixth are to be tomatoes or citrus fruits; 3 eggs a week; and about 4 1/2 ounces of butter a week. At the next level there is a diet that includes 3/4 to 1 quart of milk for children and expectant or nursing mothers, and a pint for other adults; about a pound of fruits and vegetables (divided as before) each day; and about 4 eggs and 6 ounces of butter a week. This low-cost diet, which is good but not generous, represents an increase of a fourth to a third in the quantities of the protective foods as compared with the cheapest diet that can be considered safe, whereas the top plan represents an increase of around a hundred percent. I am mentioning only the so-called protective foods in this brief discussion because it is by their quantities and proportions that the quality of a diet is judged.

I hardly need to add that none of these dietary standards formulated by responsible people is a white rabbit pulled out of a nutritionist's high hat. They are suggested only after much weighing of a mass of evidence that has been accumulating since modern nutritional research began.

Do We Get What We Need?

Now for Question 2: Do we Americans as a whole actually get what we need?

There are various ways of making comparisons and presenting data on the adequacy of our diets here in the United States. All of them add up to the same general result. As a whole, we are a long way from being well nourished by modern standards. The recent widespread study of consumer purchases and incomes has thrown some new light on this situation. As you know, this study was carried on by the Bureau of Home Economics and the Bureau of Labor Statistics, in cooperation with the National Resources Committee, the Central Statistical Board, and the Works Progress Administration, and it is probably the most extensive survey of its kind ever made. Here are some preliminary estimates made by the Bureau of Home Economics from the results of the dietary section. This study was concerned only with nonrelief families, each including a husband and wife, both native born.

Something more than half the city and village families surveyed had diets that could only be rates as poor -- that is, in one or more nutrients they failed to cover average minimum requirements and were not safe nutritionally. A little more than a third of the families had diets that could be rated as fair -- not good but passable. This leaves about 10 percent of the city and village families with good diets. One family out of every 10 had a good diet; less than 4 out of every 10 had a

passable diet; more than 5 out of every 10 had a poor diet.

Farm families show up a little better. It seems to be generally true that farm families have better diets than city or village families. Undoubtedly this is because they produce part of their own food on the farm, and this part can consist largely of protective foods. (Incidentally, it will interest you to know that village families fare worst nutritionally -- perhaps because they neither produce food for themselves nor have the advantage of city markets.) Twice as many farm families have good diets as city and village families; though we can't boast about this too much, since it merely means that 2 families out of 10 have good diets instead of 1 out of 10. A little over 4 out of 10 farm families have poor diets as compared with more than 5 out of 10 in cities and villages. Nearly 4 out of 10 farm families have diets that are passable.

If these are fair samples -- and they cover the country pretty well, and take in high, medium, and low income groups; moreover, they do <u>not</u> include <u>any</u> families on relief, any foreign born, or any broken families (I mention these because such groups tend to be in the lower income classes) -- if these are fair samples, then at least half the families in the United States live, at least part of the time, on diets that are in need of improvement. At least half our families, part of the time anyway, eat diets that in one or more nutrients are below the physiological danger line, according to conservative modern standards of nutrition. Only one or two out of every ten families eat diets that have a <u>wide</u> margin of safety -- diets that are well above the danger line and that contribute whatever the diet can contribute, which is a great deal, to

full physical and mental vigor and positive health. Three or four out of every ten families have diets that, though they are above the danger line, are possibly not far enough above for safety.

Now look at the situation in another way. These poor and just passable diets, which apparently are the diets of some 80 to 90 percent of our people, are poor or just passable because they do not furnish enough of certain nutritive elements to be classed as good. It may be calcium, or iron, or Vitamin A, or thiamin, or ascorbic acid, or riboflavin, or the pellagra-preventive factor; or it may be more than one of these. (And by the way, one of the most common deficiencies seems to be calcium.) Whatever the nutritional deficiencies are, they can be translated into terms of common foods, especially the protective foods.

The Bureau of Home Economics has been working on this kind of analysis, too. They find that <u>on the average</u>, people in this country would have to eat more than twice as much of the leafy and green vegetables and the yellow vegetables rich in carotene to consume the quantity eaten by the 10 to 20 percent of the population whose diets can be classed as good. On the average, people would have to consume 75 percent more of the tomato and citrus fruit group, and 30 percent more milk and milk products, to reach this upper nutritional level.

There is no possibility that the average diet will reach this level in any immediate future. Suppose, then, we take a much more modest goal. In order to give even passable diets to the 50 percent of our people who now have poor diets, we would have to consume, on the average, 90 percent more of certain types of vegetables than we do consume, 12

percent more of the tomato and citrus fruit group, 10 percent more butter, and 15 percent more milk. This would still leave only 10 to 20 percent of our people with good diets, but it would mean that all of the remaining 80 to 90 percent would be above the nutritional danger line.

Let me say again that only the so-called protective foods are considered in this discussion. Between good, passable, and poor diets there are differences in other valuable foods also, including some that contribute variety and richness to daily menus.

How Can We Get What We Need?

Our final question is: How can we get what we need nutritionally as a Nation and set our feet definitely on the road toward that greater physical and mental well-being pictured by Dr. McLester?

There are three barriers that may stand in the way of such a goal.

One barrier, which might prove insurmountable, we do not have in America. So far as capacity for food production is concerned, it is perfectly feasible for all the people in this country to achieve a high nutritional standard. That is not possible everywhere.

We do have the two other barriers that stand in the way of achieving a higher standard nutritionally, and it is up to the American people as a whole to decide whether those barriers are insurmountable.

One is economic. In the survey made by the Bureau of Home Economics in 1936, every city and village family spending less than $1.25 a person a week for food had a poor diet, a diet that by modern standards was below the nutritional danger line in one way or another. For a family of 4 people, $1.25 a person a week is $260 a year; for 5 people, $325

a year; for 6 people, $390 a year; for 7 people -- which would include the not uncommon number of 5 children -- $455 a year. Assume that 40 percent of the total income of the family goes for food -- a fair assumption at the lower economic levels. Then to afford $1.25 a person a week for food, a family of 4 would have to have an income of $650 a year; a family of 5, $812 a year; a family of 6, $975 a year; and a family of 7, $1137 a year. I need not tell you that great many city and village families in this country do not have those incomes. Judging by the samples surveyed in 1936, all those families have diets that are below the danger line.

We can produce enough food of the right kind for a well-nourished population; we do produce enough for a better-nourished population than we now have; but not enough people have enough income to buy the food. I am announcing no new discovery when I mention this as a hard, inescapable fact. And it is not new to say that there are two ways of attacking the difficulty -- to increase employment and raise incomes until people have enough to buy the requisites of good nutrition; or to lower the price of these requisites until they are within people's reach. Neither way is what you might call easy. To provide more employment and better incomes on a national scale inevitably means reshaping our economic system in one way or another, or finding some stimulus powerful enough to do the trick without any reshaping. Lowering prices means either finding more efficient methods of marketing, processing, and producing foods, or discovering some way to get considerable quantities of food to large groups of the population at a cost low enough to be within their reach -- which in turn would mean paying the growers and distributors of the food out of taxes.

In saying that raising incomes or lowering prices are the two ways of attacking the economic barrier to good nutrition, I do not mean to imply that they are alternatives in any strict sense. There is no reason, for example, why more efficient methods of production or processing or marketing should not go along with higher incomes.

The third barrier to good nutrition is not economic. It is the barrier of ignorance, habit, inertia. Nutritional levels in the United States by no means coincide with economic levels. It is not true that only 10 to 20 percent of our people can afford a good diet. It is not true that forty-odd percent eat a diet only a little above the danger line solely because they cannot afford any thing else, or that over 50 percent are below the danger line for economic reasons alone. This is true for large numbers; but other large numbers are not well nourished because they don't know how to select foods, or they don't think it is important enough to bother very much about. Studies made by the Bureau of Home Economics show that a few families with very little to spend for food do manage to have good low-cost diets. This is a tribute to the mothers of those families, because it is considerably more difficult to select a good diet, and to make it tasty, at a very low level of expenditure than at the higher levels. But even at more than adequate economic levels, an astonishing number of people do not eat as well as they might. And people do not learn how to eat well in a single easy lesson.

Overcoming this third barrier is a matter of continued education through all the well-known channels. And education does bring results, at all economic levels. Certain criteria indicate that college youngsters of today - who of course are among the more well-to-do groups -- are better-nourished than those of the last generation. A study among clients of a New York welfare agency showed that diet can be improved by education among the very poor. And food consumption studies for the United States as a whole show a steady relative increase in the past few decades in the use of milk and certain vegetables and fruits. There can be little doubt that the nutrition work done in many research laboratories in our time has had an effect in this country, and that the effect will be cumulative. One of the chief practical difficulties is that at the lower economic levels the opportunities for education, as well as the food budgets, tend to be limited. Yet this is where education is most needed and good nutrition is most difficult to achieve.

So the answer to our third question --how can the American people get what they need to achieve a higher standard of nutrition? -- the answer is essentially this: Raise incomes to the point where everyone can afford a fair or good diet; and educate people to the meaning of good nutrition and its importance in their own and the Nation's life. Yet I realize that is no answer, or only the beginning of an answer. What I have said is that the problem of achieving a higher nutritional average than we now have in this country goes to the roots of our

economy, including both industry and agriculture -- an economy that in the United States has been unable to avoid want in the midst of enormous resources. And that is only to state the problem in other words.

Does any man or woman living know the complete answer to that problem? We have all been trying to find the answer, strenuously, and many answers have been given. They range all the way from extreme socialism to a return to extreme conservatism. One thing is certain -- there is no easy overnight solution. Nutritional standards in America will be raised only step by step, whatever may be the ultimate ideal, and each step will involve struggle.

For myself, I think the fundamental solution can come only from the combined thought and effort and will of many men and women. You are among them. You are among them because you believe, with Doctor McLester, that "to a measurable degree, man is now master of his own destiny" -- provided he chooses to under stand certain fundamental findings of modern science and apply them in his individual and social life. It is peculiarly your job -- I think it is the true inner meaning of your job -- to help men to master their own destiny in this sense. I am not trying to give you any glib answers to issues that go so deep. I am urging you to understand the true nature of the problems and to pool your thought and effort and courage to find the answers.

SOILS AND MEN

19. The Power of Water and Clay

By Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in National Farm and Home Program, Monday, April 19, 1939.

--ooOoo--

The last time I was on this program we were discussing some of the main characteristics that make soil what it is. What were those characteristics? Well, one of them is that when you cut the soil downward, it's like a layer cake, with layers of different color and texture. These layers are called horizons. All the horizons together are called the soil profile, and each kind of soil has its own particular profile. Another characteristic is that the solid earth is not really solid. It's composed of tiny particles, which cling together in little lumps. Within and between the lumps there are small spaces filled with air and water. The lumps and spaces make up the soil structure, and it's very important to have a fairly loose soil structure so there will be room for plenty of moisture and air for plant roots.

I don't need to emphasize how important water is - just plain water. Without it, of course, farming, and life itself, would be impossible; even the human body is mostly water. Now about this water in the soil. When we have a heavy rain, a great deal of the water runs down through the upper soil layers quite rapidly and gets away. Gravity, of course, the same gravity that made Newton's apple fall, is what pulls the water down. In addition to that a good deal more water evaporates rather rapidly from the surface of the soil. Now all this water that is removed by gravity and by evaporation is lost as far as plants are concerned. All the plants can use is the water that stays in the soil in spite of gravity and evaporation. And if the soil has a good structure, a lot of water does stay in it.

What holds it there? The scientist will tell you it is held by capillary attraction. Capillary attraction is the same force that pulls ink up into a blotter. The strength of this attraction depends on the size of the spaces in the soil. If the spaces are very small, the water will stick in them with such power that neither gravity nor evaporation can readily pull it away. If the spaces are quite large, gravity will be stronger than capillary attraction and pull the water down. On the other hand, if the spaces are too small, the soil will be dense, like stiff clay, for instance, and water will have a hard time to penetrate at all.

So the soil structure makes all the difference in the world between a soil with enough moisture and a soil without enough.

Now what about the food supply in the soil, the chemicals needed by plants? Here again you get back to a question of water and soil particles. Broadly speaking, chemicals in the soil are of no use to plants until they have first been dissolved in the soil water. Plants live on a liquid diet - or maybe I should say a diet of liquid and air. The combination of water and chemicals is called the soil solution. I can compare the soil solution roughly to a sort of very thin soup, a chemical soup that fill the little spaces or pores in the soil and is constantly being sucked up by plants during the growing season. The character of this complicated soup is one of the major subjects of soil chemistry.

(over)

But the chemical nutrients in the soil don't all go into solution, or into the soup, at once. In fact, part of the chemicals are stored up in forms that plants cannot use, and these stored chemicals are only slowly dissolved and made available to plants. You might compare the arrangement roughly to having a well stocked pantry. This pantry in the soil consists of countless numbers of minute soil particles, and especially the smallest of all the particles, which are the particles of clay.

These clay particles are often much too small to be seen with the most powerful microscope. Such tiny particles are called colloids by chemists. Now colloids are a fascinating subject for study, and today they are receiving more attention than almost anything else in soil science. In fact, that is true in other branches of chemistry besides soil chemistry. The discovery of the importance of colloids opened up a whole new world for research, and it has resulted in much new knowledge of life process.

Well, I can only give you a hint of all this, but you can see that the business of furnishing plants with chemical nutrients is much more complex than it seems. For instance, when you add a fertilizer salt to the soil - say potassium chloride, for example - it doesn't immediately dissolve to make food available for plants. Some of it dissolves, but some of it gets bound up in those minute clay particles or colloids. And in exchange for what these colloids take in from the fertilizer salt, they release other chemicals into the soil solution. So when you use a certain fertilizer material, you may be adding more to the soil solution than that material itself would lead you to expect.

The clay particles are the smallest because they represent the final stage when rock or other soil material has been ground up smaller and smaller by natural forces since the clay particles store up the most nutrients, all told, the amount of clay in a soil, and its distribution, have a lot to do with the long-time productivity of the soil, its stored-up productivity.

The reason why the clay particles are so important is fairly simple. It's this way. Most of the chemical activity connected with soil particles does not take place inside them but on the outside, on the surface. Now the smaller the particles, the more there are of them in a given space, and the greater the amount of exposed surface all told. For instance, if you took the space occupied by one baseball, you could fill it with a good many marbles, and the total exposed surface on all the marbles together would be much greater than the surface of the one baseball. If you filled this same space with clay particles, too small to be seen even with a microscope, you would again increase the total exposed surface tremendously, millions of times, in fact. And the surface of each particle is a tiny laboratory or factory, where physical and chemical forces are operating full blast. Whether these forces are working for the farmer or against him depends on how well he manages the soil.

The soil chemists know a fair amount about these things now, and many of the facts are summed up in the soil science articles in the Yearbook. It's safe to say that these chemists will know much more as times goes on. As they keep finding out more, they will reduce the guesswork and increase the exactness of soil management.

And that, I guess, is as far as we can go today. Next time we're due to leave chemistry and physics and take an excursion into soil biology.

---0---

SOILS AND MEN

20. There Is No Soil Without Life

A radio talk by Gove Hambidge, Editor, Yearbook of Agriculture, broadcast in the Department of Agriculture period, National Farm and Home Program, Monday, April 24, 1939.

--ooOoo--

In the last two or three talks we've been dealing with soil physics and chemistry, trying to answer the question - what is soil? Today we're going to go into soil biology and glance at the life in the soil.

I used to think that soil was made of rock broken up fine by ages and ages of weathering. That is true, but it's only part of the truth. All true soil is made up not only of rock particles but also of material that was once alive. Without this once living material, it's impossible to have true soil; all you have is ground-up rock like pure sand, for instance. But as soon as plant material or animal material decays and becomes intimately mixed with this ground-up rock, then you begin to get true soil. Not till then.

A Yearbook article by Constantin C. Nikiforoff, of the Bureau of Plant Industry, describes this building up and renewal of soil by humus - which is decayed plant and animal material.

As you travel east or west, or north or south in the United States, there are differences in temperature, rainfall, the slope of the land, and so on. These differences help to produce different kinds of vegetation - great deciduous and evergreen forests, immense stretches of tall grass or short grass, or vast areas with only a scanty desert vegetation. It's natural that these different kinds of vegetation, combined with different kinds of climate, should produce different kinds of soil.

But in any region, under natural conditions, the soil eventually reaches a state of balance or equilibrium. This is what happens: Each year a certain amount of fresh organic matter is added to the surface from dead plants or parts of plants; a certain amount of the organic matter becomes humus; and a certain amount of the humus decays still further and finally disappears in the form of simple mineral salts, gas, and water - the last stage in the process of decay or chemical breakdown. This entire cycle, from the time the organic matter is fresh until it disappears, may be rapid or slow, depending on the degree of heat, the amount of moisture, and so on; but whether it is slow or fast, the whole thing is in balance, which means that what is added each year just about equals what disappears. Once that state of balance is reached, the region is supporting the maximum amount of life it is capable of supporting under natural conditions.

Then man steps in, removes the native vegetation, and upsets the natural balance. What he should do is to study natural processes and try to get a balance something like nature has. But he frequently does not do that. He takes away organic matter faster than he puts it back - which is like pumping the well dry.

Now some weeks ago, we saw that the whole process by which raw organic matter is turned into humus, and humus into simpler chemical compounds and elements,

(over)

is carried on by microscopic living things in the soil. These living things include bacteria of different kinds, minute fungi, molds, and a group called protozoa. Ordinarily we think of fungi, molds, and bacteria as being enemies of man, disease-producers, destroyers, but as every farmer knows, they are also friends. They take what we don't want - everything that is dead, finished, discarded - and transform it so it can be used over again to sustain life and create new life.

Charles Thom and Nathan R. Smith, of the Bureau of Plant Industry, have an article in the Yearbook dealing with these tiny living things, those micro-organisms, and the work they do in the soil.

They swarm everywhere, in regiments and armies. They are active when it's warm, inactive when it's cold. Some require oxygen; some work where there is little or no oxygen - in waterlogged soils, for instance. They attack organic matter voraciously, each kind of micro-organism taking what it needs and leaving the rest to be used by other micro-organisms or by the higher plants. Micro-organisms die, and their bodies too contribute to the supply of organic matter in the soil. Micro-organisms gobble up others, as big fish eat little fish.

The first things in living material broken down by these micro-organisms are the sugars, starches, and proteins, which can be wrecked fairly easily. The tougher stuff that makes the cell walls of plants comes next. Last comes the hard woody fiber of stems and branches, which may linger in the soil a long time, in the form of humus, before finally disappearing. As an example of the way the micro-organisms work: One set of bacteria takes what it wants from protein and leaves ammonia. Another set takes what it wants from the ammonia, and leaves nitrites. Still another set takes what it wants from the nitrites and leaves nitrates. This is something like that old rhyme about Jack Spratt and his wife. One likes the fat and the other likes the lean, so they get along fine.

There are also bacteria that can fix nitrogen from the air. They are the ones you all know about that live in little colonies on the roots of clover and other legumes. If the soil doesn't contain enough nitrogen for their use, they simply add more from the air. Some fungi live on the roots of plants, too, especially under forest conditions. The plants help to feed these fungi. In return, the fungi help to feed the plants.

Well, the soil is a home for a great many other living things besides these microscopic organisms. Immense numbers of insects live in the soil, as well as worms, and all sorts of small and large animals. The burrows of worms and insects and animals form channels through which plant roots can travel and water can get deep down into the soil. And all these creatures, from the tiny bacteria on up - they all help to make the soil what it is. There can be no soil without life - and there can be no life without soil.

Well - I guess I'll have to call it a day. Next time we're going to go into one more aspect of this interesting subject of soil science.

SOILS AND MEN

21. How Is Soil Formed?

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, in the Department of Agriculture period, National Farm and Home Program, Monday, May 29, 1939.

--ooOoo--

It's been quite a while since I was on this program, so I'll remind you that I was then discussing life in the soil. True soil, I was saying, is much more than merely ground-up rock. It is ground-up rock, of course - but added to it are the remains of everything that has lived on the earth, in various stages of decay and disintegration.

Decay and disintegration I think these are deceptive words. They suggest purely destructive processes, whereas actually decay and disintegration are part of the creative process. What happens is that in the course of growth, living things build up very complex substances out of simple chemicals. When the living things die, these complex substances are taken apart in the soil so the simpler chemicals can be used over again. This is the way life renews itself.

What is it that takes these complex substances apart in the soil? Mostly swarms, millions, billions of minute bacteria and fungi. In effect, these tiny things are like untold numbers of very active and proficient chemists, constantly working in the service of the higher plants and animals and man. No one of these chemists is anywhere near as big as a flea. But without them, there would be no renewal of materials for new generations of life. Without them, life would soon end. The earth would be cluttered up with dead matter. It is a very ancient truth that the old life must die if new life is to come into being. What is past is not done with. It is the source of more life - of new hope and new dreams for the future.

Well, we have been considering the question, what is soil? Now we will go on to another question. How is soil formed?

This subject of soil formation is covered in the Yearbook in an article written by four men in the Department - H. G. Byers, Charles E. Kellog, M. S. Anderson, and James Thorp.

They point out that the soil is not the permanent or rather changeless thing we are apt to think it is. On the contrary, it is just the opposite of changeless. What makes it soil, what makes it capable of supporting life, is the fact that changes are constantly going on in it. Something is always being added to the soil. Something is always being taken away. Something is always becoming something else. But - all these changes tend to balance each other, and for that reason the soil seems to us to be a stable thing. The soil is in a state of dynamic equilibrium, as an engineer might say.

You are in a state of dynamic equilibrium every time you walk. You tend to fall forward with every step, yet you stay upright because you have learned to balance one force with another. You watch a youngster learning to walk, you know this balancing of forces isn't an easy trick, either.

In the beginning, soil starts out as rock. There are scores of different kinds of rock, from the hardest flint down to the softest rotten stone that turns

to powder in your fingers. But these rocks can all be divided into three main groups according to how they were formed. One kind was formed from material melted in the terrifically hot furnaces of volcanoes. Another kind was formed from material laid down by rivers, by moving glaciers, and by wind. A third kind was formed by the squeezing action of tremendous masses of earth, or by the intense heat generated by this pressure. Some rocks are rich in the chemicals needed by growing plants, others are poor in those chemicals.

Now these rocks, formed in various ways, are gradually broken up by powerful forces. For instance, a rock is split apart by the expansion and contraction of heat and cold. Again, ice gets into cracks and wedges the rock apart as you would split a tree trunk with wedges and a mallet. Again, rivers and glaciers, landslides and avalanches roll small fragments of broken rock over and over, rubbing them against each other until they are ground up like wheat under a millwheel. Again, the wind sweeps sharp grit across the rocks, scouring them down like some giant with a hugh piece of sandpaper. Again, chemicals dissolved in soil water slowly eat the rocks away. All these processes together are called weathering. This weathering of rock has gone on for ages, and it is still going on.

Well, then, somewhere along the line a tiny plant gets started, maybe a lichen on the surface of the rock, or a tiny moss. Then the plant dies, and its substance mixes with ground-up rock material. Gradually more plants take hold. The plants with deep roots suck up minerals from below, and when the plants die these minerals from down below are added to the surface material. The swarms of micro-organisms become active, breaking down the remains of dead plants and turning them into humus. So after a while, you no longer have merely ground-up rock. You have a rich, complex mixture called true soil, capable of supporting abundant life. Of course not all true soils do support abundant life. There is comparatively little plant life in some desert areas - but even that little makes its contribution to the soil.

The climate, which includes heat and cold, rain and snow, and how these are distributed over the seasons - the climate has a great deal to do with the kind of soil formed in a region. The slope of the land has a lot to do with it; there is different soil on the steep mountains than down in the valleys or on a level plain. Finally, time itself has an influence. In humid regions, where there is plenty of moisture, a hundred years is enough to bring some soils to a state of maturity and balance. In some dry regions, a thousand years is far too short a time.

You will notice one thing. The kind of parent rock you have to start with does have an influence on the soil. But there are so many changes and additions as the soil-forming process goes on that no one can predict, from the nature of this parent rock, what the soil will ultimately be like. Climate and native vegetation may be much more important influences than native rock in making a soil that is good, bad, or indifferent.

Well, it's not easy to give even a broad picture of the soil-forming process like this - but it's much harder for the soil scientist to work out an accurate picture of the details - what a certain soil really consists of, just how it was formed, and how it acts. Those are the details the scientist has to work out as best he can because they have practical value for judging soils and managing them.

I guess that's all for this morning. Next time I want to say a little about the development of soil science in modern times and where it stands today.

SOILS AND MEN

22. How Soil Science Developed

Broadcast by Gove Hambidge, Editor, Yearbook of Agriculture, Monday June 5, 1939 in the Department of Agriculture period, National Farm and Home Program.

---0---

Today I want to say something about the development of modern soil science.

Up to the last part of the eighteen-hundreds, the soil scientists in Europe were mostly thinking about just one thing. They thought that what mattered more than anything else was the supply of chemicals in the soil to nourish plants. These scientists had recently made a great discovery. They had discovered that crops remove large quantities of certain chemicals from the soil, and that you have to keep putting those chemicals back into the soil if you want it to stay fertile. When the scientists made that discovery, they thought they had the whole problem of soil fertility licked. It was more or less like bookkeeping. All you had to do was to add in one column what you subtracted in the other. Then your debits and credits of soil fertility would always be balanced, year after year, indefinitely. Very simple.

And as a matter of fact, when farmers began to apply that discovery, and to add chemicals to the soil as the scientists told them to, the production of wheat per acre in Europe jumped enormously. It looked as though the soil fertility problem really was solved. But actually these chemists had discovered only part of the truth about the soil. It isn't all a matter of chemical balance by any means.

Toward the end of the eighteen hundreds, a small group of scientists in Tsarist Russia began making entirely different discoveries about the soil. Those fellows weren't much interested in chemicals. There was plenty of deep, rich, fertile, black soil on the Russian steppes -- just as there is on our own western prairies. That rich soil wasn't hungry for chemicals like the thin forest soils of Europe; it wasn't going to run out of chemicals in a hurry. So what these Russian scientists got interested in was the great differences in the soils in different regions. Those differences, they found, were quite largely a matter of the structure of the soil. Differences in climate, in vegetation, in the topography of the land produced soils with different structures and the soils acted differently. You could actually classify and describe soils on the basis of these marked characteristics.

So there came to be two schools of soil science. There were the chemical bookkeepers of Europe, working with chemicals in laboratories and on little experimental plots, adding this and that to the soil, trying to keep it in balance. And there were the soil geographers of Russia, taking

(over)

in a lot more territory, trying to find out what soils are like physically and how different soils behave. In the meantime, we had soil scientists of our own here in the United States, and they were wrestling with the problems peculiar to our soils. The greatest of our soil scientists was Dr. C. F. Marbut, of the Department of Agriculture, who died just a few years ago. Dr. Marbut combined the European and the Russian ideas about the soil and added a good many things out of our experience here in America.

Well, out of all this came the knowledge that there is no single soil problem. It isn't all a matter of chemicals everywhere. It isn't all a matter of structure. There are many different kinds of soil, and each one is a complex problem by itself. The big achievement of modern soil science some would say, is a system of classifying, describing, and mapping soils in such a way as to show clearly the important differences that make each one a separate problem. With this knowledge you can work out the management practices suited to each particular soil.

There is an account of all this in the Yearbook in an article written by Mark Baldwin, Charles E. Kellogg, and James Thorp, of the Bureau of Plant Industry.

It would take more time than I have to tell you about this modern system of soil classification. I'll only say that all the soils in the United States are gradually being mapped and classified according to this system, and the work is proving to be more and more useful every year. There is always a gang of soil surveyors out somewhere in this country, studying, observing, describing, and mapping soils. And in addition to these studies in the field, there is a lot of laboratory analysis to be done.

One of the tables in the article I mentioned by Baldwin, Kellogg, and Thorp shows the 36 great groups into which the soil scientists divide all soils. Each of these great groups, as they are called, has its own kind of profile, its own kind of natural drainage, its own kind of productivity, and its own kind of usefulness. Each great group is suited to, and in fact determines, a certain type of farming, or a certain combination of types. Each great group lies in a broad region of climate and vegetation. Then these great groups in turn can be subdivided into smaller groups, until you get down to small local variations, or even the differences in soil between parts of the same farm.

In the back of the Yearbook there is a colored map that shows the soil associations in the United States, Alaska, Hawaii, the Canal Zone, Puerto Rico, and the Virgin Islands in as much detail as is possible in a comparatively small space. And the book contains descriptions of all these soil associations.

Putting the facts about the soil onto a map, and carefully describing all the important points, is the final step in soil surveying. J. Kenneth Ableiter, of the Bureau of Plant Industry, tells about this mapping work in an article in the Yearbook. Like a road map, a soil map gives useful information in very compact form. And in the descriptions that go

with these maps, our soil surveyors are more and more including information about the natural productivity of each soil for different crops and different uses.

You'll probably be thinking that after all an experienced farmer can manage his soil pretty well without knowing much if anything about the things I've been talking about in these discussions -- such things as soil horizons, the soil profile, soil structure, soil particles, the soil solution, chemical exchange, colloids, soil bacteria, and so on. And it's quite true that in some ways the farmer's practical knowledge may be actually a jump ahead of science. But it is also true that whether he knows it or not, a great many of the things the intelligent farmer does with his soil today are based directly on the work of the scientists. The farmer tries to follow scientific fertilizer practices, scientific rotation practices, scientific cultivation practices, and so on. And there is no question but that modern soil science has discovered a great deal about how to increase the certainty of production as well as the production per acre. Though we don't always apply the discoveries of science as soon as we might or as well as we might.

With that I shall stop for today. Next time I'm going to end these talks by summing up a few broad suggestions for good soil management.

# # #